DOCUMENT RESUME

ED 142 205 IR 005 061

AUTHOR	Porat, Marc Uri
TITLE	The Information Economy: Definition and Measurement.
INSTITUTION	Office of Telecommunications (DOC), Washington, D.C.
SPONS AGENCY	National Science Foundation, Washington, D.C.
REPORT NO	OT-SP-77-12(1)
PUB DATE	May 77
GRANT	APR-7609015
NOTE	319p.; For related documents, see IR 005 061-069 ; Best copy available
AVAILABLE FROM	Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock No. 003-000-00512-7)
EDRS PRICE	MF-$0.83 HC-$16.73 Plus Postage.
DESCRIPTORS	*Economic Research; *Employment Statistics; Employment Trends; Federal Government; Industry; Information Services; *Information Utilization; Input Output Analysis; *National Surveys; *Public Policy

ABSTRACT

This report series defines and measures the "information activity" within the national economy. "Information activity" is defined to include those specific industries and occupations whose primary function is to produce, process, or transmit economically valuable information. Changes in the national labor force are analyzed over a 120-year span. This volume contains the executive summary and the major findings of the study. It defines information and includes a formal set of National Income and Product Accounts for the primary and secondary information sectors, with input-output matrices for both of these sectors. In addition, it specifies the information-related occupations of both the primary and secondary information sectors. Finally, it presents lists of information policy issues pertaining to industry, government, and the home and makes two recommendations as to how the Federal government might meet the public policy issues posed by the expansion of our information activity. (Author/DAG)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED142205

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

OT SPECIAL PUBLICATION 77-12 (1)

THE INFORMATION ECONOMY:
Definition and Measurement

BEST COPY AVAILABLE

Dr. Marc Uri Porat

This report was prepared by the Office of Telecommunications with partial support of National Science Foundation grant No. APR-7609015.

Any opinions, findings, conclusions, or recommendations expressed in this document are those of the author and do not necessarily reflect the views of the National Science Foundation or the Department of Commerce of the U.S. Government.

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

Jordan J. Baruch
Assistant Secretary for Science and Technology

OFFICE OF TELECOMMUNICATIONS
John M. Richardson, Director

May 1977

IR005061

UNITED STATES DEPARTMENT OF COMMERCE
OFFICE OF TELECOMMUNICATIONS
STATEMENT OF MISSION

The mission of the Office of Telecommunications in the Department of Commerce is to assist the Department in fostering, serving, and promoting the nation's economic development and technological advancement by improving man's comprehension of telecommunication science and by assuring effective use and growth of the nation's telecommunication resources.

In carrying out this mission, the Office

- Conducts research needed in the evaluation and development of policy as required by the Department of Commerce
- Assists other government agencies in the use of telecommunications
- Conducts research, engineering, and analysis in the general field of telecommunication science to meet government needs
- Acquires, analyzes, synthesizes, and disseminates information for the efficient use of the nation's telecommunication resources.
- Performs analysis, engineering, and related administrative functions responsive to the needs of the Director of the Office of Telecommunications Policy, Executive Office of the President, in the performance of his responsibilities for the management of the radio spectrum
- Conducts research needed in the evaluation and development of telecommunication policy as required by the Office of Telecommunications Policy, pursuant to Executive Order 11556

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Stock No. 003-000-00512-7

FOREWORD

Physics, a discipline at the heart of our last major technological revolution, yields a quotation that is highly appropriate to the present work:

> When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science.
>
> -- William Thomson, Lord Kelvin
> (1824-1907) English Physicist

Notions of yet another major revolution, one that will bring about a "post-industrial" society, have been in the air for some time now. Yet, few steps toward the measurement of this revolution's most important element -- information activities -- were taken until Dr. Porat began the investigation that is reported in these volumes. We might say, then, that this study, truly a seminal one, pushes our knowledge of an information economy closer to "the stage of science."

This report proposes a conceptual framework for defining the information activities of an advanced economy, and prescribes an objective way to quantify them. Without such definition and measurement, I cannot imagine how we can formulate sound policy for an information society. The fact that so many information policy issues are pressing upon us adds to the pertinence of the research.

It may strike some as odd that the Office of Telecommunications, an organization concerned principally with telecommunications technology, would offer a report dealing with the whole range of information activities. The explanation lies in the need to view telecommunications in the larger context of its effects on other aspects of society. Satellite networks, for example, can be an instrument for regional economic development. Retail terminals can perform banking functions. And electronic communications is steadily diminishing the volume of traditional postal delivery. Thus, it is essential to appreciate how issues internal to telecommunications influence other kinds of information activities. Conversely, ways of achieving broader policy objectives might well produce decisions affecting telecommunications services. I have in mind such goals as the provision of equal access to high-quality health care or the expansion of continuing education, both of which obviously can be facilitated by the electronic media. To the extent that telecommunications and its sister technology, computers, are at the core of the infrastructure of the information society, their relationships with the larger society are every bit as important as their internal problems.

The concepts and methods described in these volumes have begun to attract wide national and international notice. They are cited by officials of the Congress, the Executive Branch, and the regulatory agencies. They are being studied by international organizations. Yet, in spite of all the acknowledgments, this study constitutes only a point of departure toward a more complete understanding of the information society. We must devise and test alternative representations of the information economy against this one. We still have to settle on the best model, achieve comparability among models in other countries, produce trend data, and construct the methods for predicting consequences of alternative policy decisions.

I am confident that this additional work will be taken up by others. Moreover, I believe that their efforts will sharpen these concepts into a new tool, a tool of great value because of its clear relevance to the course of our world's complex societies.

John M. Richardson
Director

INTRODUCTORY NOTE

Science, commerce and technology are inextricably interconnected in American society. It is therefore fitting that this effort to clarify one aspect of their impact was a joint project of the National Science Foundation and the Department of Commerce. The National Science Foundation provided the funds needed to undertake the project, the Department of Commerce the institutional setting in which to conduct it. The bond was cemented through a common concern with telecommunications technologies and policies.

We were particularly motivated by the prospect of increasing the substance surrounding fascinating concepts about the changing nature of American society. The evident acceleration in invention and application of information technologies and the social and economic change which accompanies this development, is directly relevant to a wide range of policy concerns.

The findings of this research are provocative and concise. We trust that they will stimulate and illuminate public discussion. The report describes some of the ways in which the findings have been applied thus far. Yet it is clear that this work is an incremental contribution and that much remains to be accomplished. Work has begun in the U.S. and abroad to extend the data base developed in the project. I extend an invitation to readers to contribute their reactions to the report and their ideas on further research.

Charles N. Brownstein
Program Manager
Telecommunications Policy
Research Program
National Science Foundation, 1977.

SYNOPSIS

THE INFORMATION ECONOMY Report Series totals nine volumes, each of which has its own subtitle.

77-12(1) -- THE INFORMATION ECONOMY: Definition and Measurement -- Dr. Marc Uri Porat -- 265 pp.

This volume contains the executive summary and the major findings of the study. It defines information activity and includes a formal set of National Income and Product Accounts for the primary and secondary information sectors, with input-output matrices for both of these sectors. In addition, it specifies the information-related occupations of both the primary and secondary information sectors; this includes a consideration of private and public bureaucracies. Finally, it presents lists of information policy issues pertaining to industry, government, and the home and makes two recommendations as to how the Federal government might meet the public policy issues posed by the expansion of our information activity.

77-12(2) -- THE INFORMATION ECONOMY: Sources and Methods for Measuring the Primary Information Sector (Detailed Industry Reports) -- Dr. Marc Uri Porat -- 188 pp.

This volume presents reports of the 25 major industries that compose the primary information sector. The volume's classification scheme is based on the Bureau of Economic Analysis Input-Output Matrix. Each industry is discussed in great detail. The discussions include the reasoning behind considering the industry as part of the primary information sector, a breakdown of the subordinate industries that compose the larger industrial category, a narrative of the informational aspects of the industry, and a report of the final demand and value-added components. The service, manufacturing, and construction sectors of the economy are considered.

* * * * * * *

We call to the reader's attention that the most critical part of the entire report series is to be found in the first two volumes. The remaining volumes are essentially supplements to and extensions of Volumes 1 and 2.

77-12(3) -- THE INFORMATION ECONOMY: The Interindustry Transactions Matrices (1967) -- Dr. Marc Uri Porat, with the assistance of Michael R. Rubin -- 58 pp.

Volume 3 consists of input-output tables showing transactions in the 1967 economy. One table shows a breakout of 108 industries, another of 190 industries.

77-12(4) -- THE INFORMATION ECONOMY: The Technology Matrices (1967) -- Dr. Marc Uri Porat, with the assistance of Michael R. Rubin -- 117 pp.

Volume 4 includes A-coefficient matrices for the 1967 economy at both the 108 and 190 levels of detail.

77-12(5) -- THE INFORMATION ECONOMY: The "Total Effect" Matrices (1967) -- Dr. Marc Uri Porat, with the assistance of Michael R. Rubin -- 117 pp.

This volume contains the 1967 Inverse Matrices with detail at both the 108 and 190 industry levels.

Volumes 3 through 5 contain backup information to Chapters 6 and 10 of Volume 1.

77-12(6) -- THE INFORMATION ECONOMY: The Labor Income by Industry Matrix of Employee Compensation (1967) -- Dr. Marc Uri Porat, with the assistance of Michael R. Rubin -- 100 pp.

Volume 6 consists of a table of 422 occupations and 108 industries showing the wages paid by each industry to each occupation in 1967.

77-12(7) -- THE INFORMATION ECONOMY: The Labor Income by Industry Matrix of Employee Compensation (1970) -- Dr. Marc Uri Porat, with the assistance of Michael R. Rubin -- 91 pp.

Volume 7 consists of a table of 422 occupations and 108 industries showing the wages paid by each industry to each occupation in 1970.

Volumes 6 and 7 contain backup information to Chapter 7 of Volume 1.

77-12(8) -- THE INFORMATION ECONOMY: National Income, Workforce, and Input-Output Accounts -- Dr. Marc Uri Porat, with the assistance of Michael R. Rubin -- 91 pp.

This volume contains backup material to Chapters 4 and 9 of Volume 1. It consists of a number of tables, including those that show trends in the labor force over time and National Income Accounts information.

77-12(9) -- THE INFORMATION ECONOMY: User's Guide to the Complete Database -- Michael R. Rubin -- 71 pp.

This volume is a user's guide to the computer model which describes the information elements of the economy in the benchmark year 1967. The database is available on magnetic tape through the National Technical Information Service, Springfield, Virginia, Accession No. PB-264 172, titled "The Information Economy."

ACKNOWLEDGMENTS

This report was prepared with partial support of National Science Foundation grant No. APR-7609015. Any opinions, findings, conclusions, or recommendations expressed in this document are those of the author and do not necessarily reflect the views of the National Science Foundation.

A dissertation entitled The Information Economy is available from: University Microfilms, 300 N. Zeeb Road, Ann Arbor, Michigan 48106 (Attn: Dissertation copies), Accession No. 77-7147.

To Fritz Machlup and Daniel Bell I owe a deep intellectual debt for plowing the field so thoroughly and proficiently before me. After their contribution, mine was simply to harvest the crop that they had planted; and there is ample left for future researchers who wish to embark on this new line of research.

My early ideas, ill formed and overly ambitious, were skillfully and gently molded by the able hands of Professors Edwin Parker and James Rosse. They had the good sense to say both yes and no at just the right moments, and were always accessible when I needed guidance. The last and most critical year of this work was made possible through the good graces of Dr. John Richardson, Director of the Office of Telecommunications, who gave freely of his encouragement and support, and who smoothed the bureaucratic wrinkles when they seemed to mount like tidal waves. He understood the policy implications of this work before most.

Generous financial support from the National Science Foundation was the lifeblood for this project. Dr. Charles Brownstein (RANN/Division of Advanced Productivity Research and Technology) managed the project most professionally, and his advice and consent were very helpful and greatly appreciated.

Over the course of the project, I drew heavily on the talents and energies of many people, and to them I extend a special gratitude. Michael Rubin, who joined me nearly three years ago, single handedly slew the computer dragon. His all night sessions outnumbered mine by two to one, and resulted in Chapters 6, 7, & 10. Joseph Kashi assembled most of the government and labor data of Chapters 7 and 8. Deborah Semb and Barbara Mikelson delivered the National Income and Product Accounts and time series of Chapters 4 and 5.

From the thousand and one production nightmares, I was rescued by the skill and perseverance of Fran Sills. She administered endless drafts of tables and text with dispatch and poise, working many evenings and weekends at top efficiency. Her performance in this project was superb. Glynetta Perrymore endured the dark ages of word processing through five complete drafts of the text. Edith Uunila thoroughly and competently helped with the final stages of proofreading and editing.

Along the road, many kind people lent me a helping hand. At the Bureau of Economic Analysis, I was given free reign by Philip Ritz, Chief of the Interindustry Division. Carolyn Knapp and Elizabeth Spaulding helped with the more obscure procedures used in the national accounts. Howard Schreier helped with programming the final demand and value added tables.

At the Bureau of Labor Statistics, I extend my thanks to Charles Bowman and the input-output staff of the Economic Growth Project. The early labor data were provided by John Shew and Karen Hassmer, and their help is acknowledged.

Although I gratefully share the credit with my friends and colleagues, I relieve them of any responsibility for remaining errors.

TABLE OF CONTENTS

Page
Foreword iii
Introductory Note v
Synopsis vi
Acknowledgments viii
List of Tables xi
List of Figures xv

CHAPTER

ONE Executive Summary 1
TWO The Six-Sector Economy 15
THREE The Primary Information Sector 22
FOUR Consolidated Accounts of the Primary Information Sector 43
FIVE Secular Trends of the Primary Information Sector 63
SIX The Primary Input-Output Matrix 72
SEVEN Information Occupations 104
EIGHT The Public Bureaucracies 136
NINE The Secondary Information Sector 148
TEN The Secondary Input-Output Matrix 186
ELEVEN The Elements of Information Policy 204
Bibliographic Data Sheet 250

LIST OF TABLES

TABLE PAGE

CHAPTER ONE

1.1 The Structure of the Information Economy (1967) 7

CHAPTER THREE

3.1 Typooogy of Primary Information Sector Industries.. 23
3.2 Detailed Typology of the Primary Information Sector 27
3.3 Functional Cost and Employment for the Typical Commercial Bank 31
3.4 Summary of Banking Industry Accounts 32
3.5 Breakdown of Employee Compensation in Finance & Insurance 35
3.6 Typology of Information in the Health Industry 37
3.7 Average Number of Hours per Week Allocated to Different Activities by Type of Profession 39

CHAPTER FOUR

4.1 Comparison of Machlup Approach with the Primary Information Sector Final Demand (Using National Accounts Concepts and Definitions) 46
4.2 GNP Concepts: Income and Product 48
4.3 Index to the Primary Information Sector Accounts at Different Levels of Aggregation 49
4.4 Gross National Product, 1967 50
4.5 Gross National Product by Major Type of Product and Purchaser, 1967 52
4.6 National Income by Type of Income, 1967 53
4.7 Breakdown of Corporate Profit in the Primary Information Industries 54
4.8 Gross Product Originating by Industry, 1967 55
4.9 Gross Product by Industty, Total and by Components, 1967 57
4.10 Components of Final Demand at the 2-Digit SIC Level 60
4.11 Components of Value Added at the 2-Digit SIC Level 61

TABLE PAGE

CHAPTER FIVE

5.1 Knowledge Production: Rates of Increase for All Branches, 1954-1958 and 1947-1958, or Similar Periods ... 64
5.2 National Income by Industry, 1929-1972 ... 66
5.3 Growth Rates for the Primary Information Sector National Income, 1929-1972 ... 70

CHAPTER SIX

6.1 Alternate Estimates of the 1967 Gross National Product ... 74
6.2 Input Requirements of the Computer Industry (IO #51) for 1967 ... 75
6.3 First Round Indirect Effect of a $1 Million Sale of Computers ... 76
6.4 Second Round Indirect Effect of a $1 Million Sale of Computers ... 76
6.5 Total Effects of a $1 Million Computer Sale ... 77
6.6 Summary of the Experimental Changes in Defense Expenditures and Personal Consumption Expenditures 85
6.7 Net impact on Output and Employment of a 20 Percent Compensated Cut in Defense Spending ... 86
6.8 Total Net Output Impact of a Compensated Defense Cut 88
6.9 Total Net Labor Impact of a Compensated Defense Spending Cut ... 89
6.10 Summary of Experiment I: Net Output and Employment Impacts ... 90
6.11 Summary of the Experimental changes in Gross Capital Formation (GCF) ... 94
6.12 Net Impact on Output and Employment of Doubling Gross Capital Formation in Information Capital ... 95
6.13 Summary of Experiment II: Net Output and Employment Impacts ... 96
6.14 Examining the Structural Depth of Information and Non-information Industries ... 99

CHAPTER SEVEN

7.1 Typology of Information Workers and 1967 Compensation ... 107
7.2 Knowledge Producers ... 108
7.3 Knowledge Distributors ... 110
7.4 Market Search and Coordination Specialists ... 112
7.5 Information Processors ... 114
7.6 Information Machine Workers ... 116
7.7 Occupations Allocated 50% to Service and 50% to Information ... 119
7.8 Occupations Allocated 50% to Industry and 50% to Information ... 119
7.9 Labor Income in the Primary Information Industries .. 124
7.10 Labor Income in the Secondary Information Industries 126

TABLE PAGE

7.11 Labor Income in the Noninformation Industries....... 127
7.12 Summary of Proprietors' Income...................... 128
7.13 Labor and Capital Shares in the Corporate Sector.... 129
7.14 Employee Compensation in Governments................ 130
7.15 Labor Income Summary................................ 132
7.16 Compound Annual Growth Rates of the Labor Force..... 133

CHAPTER EIGHT

8.1 Inputs of the Federal Information Industries 1958-1970.. 141
8.2 Outputs of the Federal Information Industries 1958-1970.. 143

CHAPTER NINE

9.1 Partial List of Information Quasi-Firms Within Non-information Enterprises....................... 150
9.2 Gross Product by Industry Total and by Components, in the Secondary Information Sector 1967.......... 155
9.3 Gross Product Originating by Industry in the Secondary Information Sector, 1967................ 158
9.4 National Income by Type of Income of the Secondary Information Sector, 1967.......................... 159
9.5 Value Added Components of the Secondary Sector (20 Order).. 160
9.6 Gross National Product of the Secondary Information Sector, 1967...................................... 161
9.7 Final Demand Components of the Secondary Sector (20 Order).. 164
9.8 Time Series of National Income Originating in the Secondary and Primary Information Sectors, 1929-1974.. 167
9.9 Time Series of National Income Originating in the Information Sectors, 1929-1974................... 171
9.10 Net Growth of the Two Information Sectors Compared to National Income and GNP 1929-1974............. 173
9.11 Productivity and Information Overhead Expense 1929-1974.. 177
9.12 GNP Deflators and Secondary Sector Deflators, 1946-1974.. 181
9.13 Inflation in the Secondary Information Sector, 1946-1974.. 182

CHAPTER TEN

10.1 Outputs of the Secondary Information Industries..... 190
10.2 Hypothetical Variable Costs of Producing a Non-Information Good................................... 194

LIST OF TABLES - Cont'd

TABLE PAGE

10.3 Total Secondary Information Requirements Generated by Personal Consumption of Non-Information Goods and Services.................................... 198
10.4 Information Content of a $2.00 Pharmaceutical Product.. 199
10.5 Derivation of Pure Secondary Information Services (Net Advertising)................................ 201
10.6 Information Requirements Generated by Demand for Non-Information Goods and Services............... 202

CHAPTER ELEVEN

11.1 Information Technology and the Primary Information Industries.. 214
11.2 Information Technology and the Noninformation Sectors.. 220
11.3 Information Technology in the Government, Home and Office... 230

LIST OF FIGURES

FIGURE PAGE

CHAPTER ONE

1.1 The Information Policy Framework.................... 9

CHAPTER TWO

2.1 Flow of Goods and Services (Market Transactions).... 17
2.2 Flow of Information (Non-Market)................... 18
2.3 Flow of Labor (and Income)......................... 19

CHAPTER THREE

3.1 The Market for Accounting Information Services...... 26
3.2 A Bank... 30
3.3 A Physician's Office................................ 36

CHAPTER SIX

6.1 Input-Output Transactions Table Showing Major Sectors.. 73

CHAPTER SEVEN

7.1 Time Series of U.S. Labor Force (1860-1980) Two Sector Aggregate by Percent.................. 120
7.2 Four Sector Aggregate of the U.S. Work Force by Percent (1860-1980)........................... 121
7.3 Net Growth Rates of Information Occupations......... 133

CHAPTER EIGHT

8.1 The Federal Information Industry................... 138

CHAPTER NINE

9.1 Time Series of National Income Originating in the Information Sectors............................. 170
9.2 Net Growth of the Two Information Sectors.......... 174
9.3 Productivity and Information Overhead Expense, 1929-1974.. 179

LIST OF FIGURES - Cont'd

FIGURE PAGE

CHAPTER TEN

10.1 Input-Output Schematic Diagram Showing the Primary Information Sector.............................. 189
10.2 Input-Output Schematic Diagram Showing the Secondary Information Sector.............................. 192

CHAPTER ELEVEN

11.1 An Information Policy Framework.................... 208

CHAPTER ONE

EXECUTIVE SUMMARY

We began this study with two major goals in mind: to define and measure an "information activity" in the U.S. economy; and to examine the structure of the information activity with respect to the rest of the economy. A third goal, not a part of the original study but which developed as interest in the project grew, was to discuss the implications of our findings: what it means for the U.S. to evolve from an economy that is based primarily in manufacturing and industry to one that is based primarily in knowledge, communication and information.

This summary chapter is organized into five brief sections:

1. The question, where we state the problem and develop the definitions used in the study.

2. The method, where we use the National Income and Product Accounts and the input-output tables of the U.S. economy to solve our measurement "puzzle."

3. The findings, where we see that 46% of the Gross National Product is bound up with the information activity; and where we discover that nearly half the labor force holds some sort of an "informational" job, earning 53% of labor income.

4. The implications, where we focus on the "horizontal" impacts of new information technologies across the major sectors of the economy, resulting in numerous "information policy" issues; and where we suggest that the Executive loci of responsibility are numerous and disparate.

5. The recommendations, where we argue that the Federal government should adopt a more horizontal view of information policy, coordinating issues that cross traditional industry and Departmental lines; and where we consider whether to continue monitoring the information sector in the National Income and Product Accounts.

1. The Question

Fritz Machlup first attempted to measure the share of the U.S. GNP connected with knowledge as opposed to other kinds of activities.[1] If we are to make bold statements about the U.S. as a "post-industrial society" or an "information economy," then it is incumbent upon us to provide at least that summary statistic. The question: *What share of our national wealth originates with the production, processing and distribution of information goods and services?* Or, what is the extent of the information activity, (as opposed to agriculture, services or industry), as a portion of the total U.S. economic activity?

An economy can be separated into two domains. The first is involved in the transformation of matter and energy from one form into another. The second is involved in transforming information fron one pattern into another. The two domains are linked and inseparable. Manipulation of matter and energy would be impossible without a sizable input of knowledge, planning, coordination, and control information. And the production, processing, and distribution of information would be impossible without a sizable input of matter and energy. The systematic marriage of these two domains is absolute. The question is the relative contribution of each partner in producing economic wealth.

Information is not a homogeneous good or service such as milk or iron ore. It is a collection or a bundle of many heterogeneous goods and services that together comprise an activity in the U.S. economy. For example, the informational requirements of organizing a firm include such diverse activities as research and development, managerial decision making, writing letters, filing invoices, data processing, telephone communication, and producing a host of memos, forms, reports, and control mechanisms.

Our first burden is to offer a definition of an "information activity" that is intuitively reasonable, makes economic sense, and is measurable.

We offer the following: *Information is data that have been organized and communicated. The information activity includes all the resources consumed in producing, processing and distributing information goods and services.*

To organize data into information, one needs to superimpose order: a system of logic, a system of thought, a system of measurement, a system of communication. To communicate these organized data, one requires three elements: a communicator, a channel of communication, and a receiver. The operational definition of information used in this study goes beyond the narrow definition offered above, encompassing all the workers, machinery, goods and services that are employed in processing, manipulating or transmitting information. The telephone, the computer, the printing press, the calculator, the manager, the secretary and the programmer -- these are all essential members of the information activity. It would be almost impossible to handle information without resorting to these resources.

A wide variety of *information capital* resources are used to deliver the informational requirements of one firm: typewriters, calculators, copiers, terminals, computers, telephones and switchboards. And depending on the size of the firm, there could be a massive array of high technology information goods such as microwave antennae, satellite dishes and facsimile machines. On the labor side, the firm has to employ the services of many different types of *information workers*, who together satisfy the firm's informational requirements. We find the research scientist, engineer, designer, draftsman, manager, secretary, clerk, accountant, lawyer, advertising manager, communications officer, personnel director -- all essentially paid to create knowledge, communicate ideas, process information -- in one way or another transform symbols from one form to another. The information workers and the information capital are housed in "information buildings": office buildings, schools and other structures where the primary activity is to manipulate information. They also consume a wide variety of *information goods and services*, such as telecommunications, business consulting, legal advice, paper and office supplies.

We have offered an inductive definition of what is to be included as information capital. It is also operational. We can now select at a very fine level of detail from amongst the many hundreds of machines and instruments that correspond to this broad definition of "information capital." Most goods are not ambiguous. A tractor is obviously a member of the food activity, and a seismograph is a member of the information activity. The few capital goods that are ambiguous were usually eliminated from the definition so that errors are overly restrictive rather than overly inclusive.[2]

The definition for information labor is symmetrical to information capital. We looked at each of the 422 occupations that are reported by the U.S. Census and the Bureau of Labor Statistics and asked the following question: Does this worker's income originate primarily in the manipulation of symbols and information? Clearly, all human endeavor contains some component of information processing. Without information processing, all cognitive functions would cease and there would be no human activity. But that definition is operationally useless. We are not saying that information workers deal exclusively in information and other kinds of workers never deal in information. Rather, we assert that certain occupations are primarily engaged in the manipulation of symbols, either at a high intellectual content (such as the production of new knowledge) or at a more routine level (such as feeding computer cards into a card reader). And for other occupations, such as in personal service or manufacturing, information handling appears only in an ancillary fashion. It is a distinction of degree, not of kind. Using this test, we divided the 422 occupations into two major groups -- information and noninformation.[3] The information group was further subdivided into approximately 30 smaller groups, as reported in Chapter 7.

Having arrived at a working definition of information -- one that could be translated from concept to measurement -- we then turned our attention to the producers and consumers of information in a market sense. Who produces information goods and services? Who consumes them? And, more importantly, can we determine what portion of the Gross National Product is bound up with the provision of the information activity?

We approach this problem by casting information in a market and a nonmarket context. The former refers to any information good or service which is exchanged across a recognizable marketplace. The supply side (firms and industries) is described; the demand side (other firms, households, governments, and exports) is described; and the good or service has a known market price. *The "primary information sector" includes those firms which supply the bundle of information goods and services exchanged in a market context.* In 1967, 25% of GNP originated in the primary information sector.[4]

In addition to the primary information sector, we know that a tremendous volume of information is produced and consumed within firms and governments and never transacted across recognizable markets. We argue that every noninformation firm supports a sizable collection of "quasi-firms" whose job is to provide basic information services: R&D, data processing, telecommunication, typing, management, accounting and so on. The cost of these information services is embedded in the market price of the firm's primary output. *The "secondary information sector" includes all the information services produced for internal consumption by government and noninformation firms.* In this sense, the production of information services is ancillary or "secondary" to the production of a noninformation good. For example, a portion of an automobile's market price pays for the R&D, management and advertising services necessary to bring the product to market. The "value" of the secondary information services is measured by imputing a shadow price as if these services were bought from the primary information sector.

The secondary information sector is intuitively analagous to the private and public bureaucracies, or Galbraith's "technocracy". The sector is the repository of the planning, decision-making and control apparatus in the economy. As we shall argue, planning is a major feature of an information economy. We shall provide a price tag for these activities by industry, summing to 21% of GNP in 1967.

We now have the basic definitional framework used throughout this study. We defined what we mean by information generally. We saw examples of information capital and information labor. And we divided the information activity into two major sorts: one in the primary information sector where information is exchanged as a commodity, and one in the secondary information sector where information is embedded in some other good or service and not explicitly exchanged.[5] The next phase is measurement.

2. The Method

Information activities are scattered throughout the National Income and Product Accounts and our economic censuses. Our job is to extract the many tiny pieces, often buried and lost, to form a coherent picture of an information economy.

We treat the problem as a two-part puzzle. The first part is building the primary information sector; the second part is finding a way to measure the value of the secondary information services.

Constructing the Primary Information Sector

A major goal of this study is to build a set of accounts for the primary information sector that are completely consistent with the National Income & Product Accounts. By relying completely on the Bureau of Economic Analysis (BEA) conventions and definitions, we have built a set of accounts (in Chapter 4) that can be directly compared with the other sectors in the economy.

The actual task of constructing the primary information sector is relatively straightforward. Each candidate industry is decomposed at the finest level available from the census (7-digit SIC). Certain industries, such as computers and telecommunications, offer no problem and can be "lifted" intact from the manufacturing or service sector. Others, such as finance and real estate, offer considerable difficulties, and must be examined more closely. The techniques for that examination vary with industry, and are reported fully in Volume 2.

Data on the components of final demand (personal consumption, gross capital formation, government expenditures, net exports) and value added (employee compensation, profits, depreciation, and indirect business taxes) are gathered using the BEA input-output worktape.[6] After the industry microdata are assembled and "cleaned," they are aggregated into a formal set of national accounts.

Constructing the Secondary Information Sector

The secondary sector is somewhat more complicated. How does one measure the value of an information service that is never sold across an established market? To simplify the explanation (found in Chapter 9), we argue that the value of the service is composed of the labor and capital resources consumed in producing the service. A business letter requires information workers -- to write, type, correct, file, and mail. It also requires information goods -- a dictaphone, typewriter, photocopier and file cabinet.

And the entire activity is housed in "information buildings" -- offices -- as a form of information capital. Hence, in a strict national accounting sense, the value added in the secondary information sector is composed of two measurable inputs:

(i) the employee compensation of information workers employed by noninformation industries, and

(ii) the depreciation taken on information capital goods purchased by noninformation industries.

Having devised a strategy for solving our puzzle, we begin to assemble the many pieces. First, we use a Bureau of Labor Statistics (BLS) matrix that shows the detailed occupational structure of all U.S. industries. We convert the matrix to show employee compensation (discussed in Chapter 7), rather than the number of workers. That task enables us to measure, by industry, the wage bill of the information workers employed by noninformation industries.

Second, we use a BEA matrix that shows the detailed capital flows of all U.S. industries. By making some simplifying assumptions, we are able to measure the depreciation taken on information capital goods used by noninformation industries.

Together, these two data bases provide the minute pieces for the puzzle. By aggregating the pieces following national income accounting rules, we can build a set of accounts for the secondary information sector, as shown in Chapter 9.

We also built an input-output (I-O) model showing the structure of the two information sectors. The I-O model provides us with a rich data base regarding interindustry flows of information goods and services. Several applications of I-O analysis appear in Chapters 6 and 10.

3. The Findings

Table 1.1 summarizes the major findings regarding the share of GNP originating in the primary and secondary information sectors. National wealth (GNP) can be measured in two ways. "Final Demand," or the product side of the account, includes all the purchases of households, governments and foreigners. It also includes the nation's investment in machinery and buildings. The thousands of goods and services included in the primary information sector accounted for 21.9% of final demand (GNP) in 1967. In addition, the sales of the secondary information sector to final demand accounted for 3.4% of GNP.

But final demand is not an accurate measure of economic wealth. It only counts the revenues from final sales and eliminates intermediate demand. Hence, a group of industries which sell mostly to intermediate demand (other firms) captures a smaller share of GNP than a group which sells exclusively to final demand.[7]

TABLE 1.1: THE STRUCTURE OF THE INFORMATION ECONOMY (1967) (Millions of $)

PRODUCERS	INTERMEDIATE CONSUMERS			FINAL DEMAND	% GNP
	Primary	Secondary	Noninformation		
Primary Information Sector	$69,754	$78,917	0	$174,585	21.9%
Secondary Information Sector	0	616	227,778	27,440	3.4%
Noninformation Sector	59,538	0	571,503	593,363	74.6%
VALUE ADDED	199,642	167,826	427,920	GNP = $795,388	
% of GNP	25.1%	21.1%	53.8%		

The value added side of the accounts is a more accurate representation of wealth, as it is not biased by the peculiarities of who purchased the good.

In 1967, 25.1% of value added originated in the primary information sector. In addition, 21.1% of value added originated with the provision of secondary information services. The two pieces are conceptually and empirically distinct; they are also additive. *The total information activity, including both market and nonmarket transactions, accounted for 46% of GNP in 1967.*

The composition of the workforce is also a basic indicator of our economic development. Between 1860 and 1905, the agricultural workers dominated the labor force, followed by industry, services and information. Between 1905 and 1955, the industry sector took the lead. But by 1955, the information sector became predominant, rising from a low of 15% of the workforce in 1910 to over 40% in 1970. Information workers earned over 53% of all labor income in 1967 (see Chapter 7).

These major findings motivate the argument that the U.S. has now emerged as an information-based economy.

4. The Implications

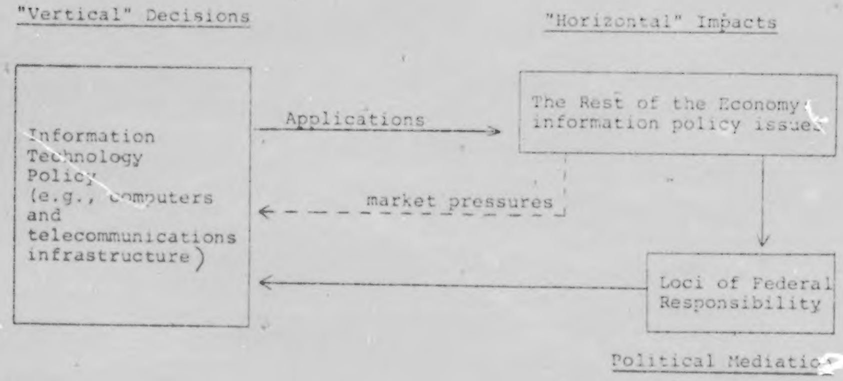
In the last Chapter, after our excursion through the information sectors is ended, we trace some of the effects of information technology on the overall economy. In a rudimentary fashion, we begin to define the elements of "information policy."

The major implication is that as information technologies "invade" various sectors of the economy, old arrangements may come into conflict with the new. Applications of the new technologies may raise either economic issues or value conflicts that previously lay dormant. The seeds of tomorrow's opportunities and difficulties are sown today. And therein lies the presumption that information policy should adopt a prospective look at future applications of information technology.

The framework for understanding information policy is sketched in Figure 1.1. It will be expanded further in Chapter 11.

A major distinction is drawn between the "vertical" attention given to issues within the telecommunications and computer world, and the "horizontal" effects of the technology on the overall economy. This perspective is important, given that policy attention is today almost exclusively directed at the vertical issues.

FIGURE 1.1: THE INFORMATION POLICY FRAMEWORK


"Vertical" Decisions
"Horizontal" Impacts
Information Technology Policy (e.g., computers and telecommunications infrastructure)
Applications
The Rest of the Economy: information policy issues
market pressures
Loci of Federal Responsibility
Political Mediation

But as new applications are found for information technology, the horizontal impacts march to the forefront of the policy conflict. We already hear the opening drumrolls of (horizontal) conflict from those industries whose technical characteristics are inexorably converging, and whose economic stakes are loosening in the shifting sand. I cite the edgy and uncomfortable feeling in the U.S. Postal Service as electronic mail approaches; I cite also the polite realignments in the finance industry as electronic funds transfer systems threaten to extinguish certain distinctions between commercial banks and S&L's, between a branch office and a point-of-sale terminal.

Some policy issues are more closely akin to social rather than economic concerns, to questions of value. I cite the fortunate public outcry against the universal Personal Identification Number; I cite also the populist concern with unequal distribution of (or access to) information resources.

In the final Chapter, we list dozens of potential policy issues borne of new information technology applications. We also tie, wherever possible, the policy problem to the executive agency which serves as a locus of responsibility. An immediate observation is that there exists no coherent locus of executive responsibility. Hence, prospective attention to information policy matters is applied unevenly and without broad interdepartmental guidance.

To close the information policy loop, we observe that some of the policy solutions may generate pressure on the keepers of the infrastructure. That is, the horizontal impacts of information technology may generate problems that, after political mediation, return to the doorstep of the vertical decision-makers. For example, a USPS decision to implement an extensive electronic mail system may impose design criteria that run afoul of plans for an extensive EFT network. The FCC commissioners, as chief representatives of the vertical axis, may find themselves in the odd position of setting *de facto* postal service or banking policy. What the FCC permits or denies the owners of the information infrastructure ultimately expands or restricts the options of "horizontal" users.

Conversely, bankers and Postal Commissioners may discover, to their chagrin (or delight) that *de facto* policy has been set for them because of the shape of the infrastructure. Relative costs of using alternative configurations of information technology can preclude or encourage certain applications. This is the two-way street between the vertical and horizontal communities.

We may find that issues are resolved through the discipline of the marketplace. Competitive pressures, both national and international, may moot governmental intervention and achieve solution without direct regulation. But where the market alone cannot achieve efficiency or equity, information policy issues may continue to rattle unceremoniously in the corridors of the Executive agencies. Coordination and consultation *increase* the likelihood of achieving market solutions. In this spirit, we hold that one sign of a successful information policy is that direct government intervention is replaced by prospective problem-solving.

5. The Recommendations

Two major recommendations flow from this study, one regarding the formulation and implementation of information policy, the other regarding the merit of institutionalizing the information sectors in the national accounts. Both are discussed in Chapter 11.

Recommendation 1:

> *In response to emerging horizontal information policy issues, the Executive Branch should establish an appropriate organization to coordinate interdepartmental policy formulation.*

The need for a Federal information policy office stems from three sources: (i) from the unresolved economic or social conflicts arising from new applications of information technology; (ii) from the absence of clearly articulated goals and objectives in the Executive; and (iii) from the lack of interdepartmental coordination of those Federal agencies that hold statutory authority for resolving the conflicts.

Such a response might take the form of an Office in the EOP (e.g., in OTP or OMB) whose charge is to develop a process of interdepartmental consultation and coordination. This process should include the relevant Departments, with input from private sector interests, public interest groups, and disinterested parties.

The incentive to participate in such a forum is tied to the budget process. The proximity of the Office to the EOP serves to facilitate budget approval of those mission programs which are involved in information policy. In effect, this Office "represents" the mission-oriented agencies' programs to OMB. In Chapter 11, we explore the idea in greater detail.

Recommendation 2:

> *The Bureau of Economic Analysis (BEA) should be requested to review the usefulness of constructing permanent information sector accounts.*

The concept of an "information activity" has not yet passed scientific and political muster, except on a limited basis. Hence, we feel that a decision to institutionalize the accounts on a permanent basis is not yet warranted.

The two reasons in favor of institutionalizing the accounts are: (i) to develop a meaningful time series for academic research purposes, and (ii) to establish a foundation for further focus on "information policy" issues.

On the academic agenda, it is clear that meaningful econometric analysis is stalled without systematic time series data, gathered in a consistent, accurate and timely manner. The cross-section (1967) developed in this study does not meet the academic objective. Also, no research effort can hope to achieve the turnaround time of the BEA in producing annual estimates. If current reports are in demand, then the BEA is a natural agency to approach.

On the policy agenda, we have discovered that the existence of a single set of (1967) accounts has served as a foundation for political conjectures and assertions. The very existence of an official set of accounts serves to focus policy attention on previously ignored issues. For example, after the Department of Commerce started producing reports on capacity utilization, policy attention regarding that important statistic was heightened.

The reasons that we do not recommend to institutionalize the accounts turn on two issues: (i) the decision to incorporate the information sector into the National Income and Product Accounts is not OT's to make, but is the prerogative of the BEA, and (ii) the academic and policy communities' interests and criticisms have not been fully expressed.

We hope that this nine-volume report series will generate a fruitful dialogue between the academic and policy interests. The decision can wait until the jury has returned.

* * * * * *

Returning to our two main goals, defining and measuring the structure of an information economy, we are now ready to report the results. The next nine chapters contain the elements of the "puzzle" explained earlier in the introduction. Each piece of the puzzle is introduced and fitted into the larger picture. All the statistical pieces of the labor force and industry "lock" into place around the input-output matrix. They are completely reconciled internally and with the National Accounts.

Interpreting the implications of an information economy is a riddle with many solutions. Our purpose is served if the basic statistical foundation for the idea is sound. Once the "soapbox" is built and can support the weight, we gladly invite others to Hyde Park for the inevitable debates.

FOOTNOTES

[1] Fritz Machlup, *The Production and Distribution of Knowledge in the United States*, Princeton University Press, New Jersey, 1962.

[2] An example of an ambiguous capital good is a clock. A clock obviously gives one information about the time of day, but a clock also has value as an ornamental piece, as furniture or, in the smaller version as a watch, as a piece of jewelry. Treatment of this ambiguous category is as follows: the casing portions of a clock or watch (the ornamental or jewelry component) was measured separately from the clock mechanism itself. This sorting out was done at a very tedious and minute level as this example illustrates, and gives us fair assurance that the definition of information capital was followed quite faithfully in the measurement effort.

[3] Including a third group of around 30 occupations which are "ambiguous," e.g., nurses, managers of retail establishments, foremen.

[4] The Federal government produces certain services (e.g., printing and publishing, data processing) that are directly analagous to those produced in the primary information sector. The GNP share of these activities in 1967 was 5.1%

[5] One slight deviation from this definition is in the treatment of government, and we should make that clear in advance. The government engages in activities that are both like the primary information sector and like the secondary information sector. Where the Federal government maintains a printing office of a data communications network, it clearly emulates firms in the primary information sector. The economics and the technology of operating a government printing office are quite similar to those of a private printing firm. We therefore built a separate government industry in the primary information sector. Likewise, the value of the "secondary" information services consumed by governments appear in our secondary information sector. The GNP share of these activities in 1967 was 2.3%.

[6] The Bureau of Economic Analysis (BEA) of the Department of Commerce publishes a magnetic tape of the input-output (I-O) matrix. The detailed data were drawn from an unpublished work-tape underlying the aggregate I-O tables.

[7] This is apparent by example. Crude petroleum is not a consumer item: governments do not purchase it; almost none is exported; and it is not an investment good. The share of U.S. final demand attributable to crude petroleum is a mere $339 million -- or 0.04% of GNP. But the crude petroleum industry is a lucrative source of profits and wages. On the income side of the account -- value added -- the industry created $8,611 million, or 1.08% of GNP.

CHAPTER TWO

THE SIX-SECTOR ECONOMY

The purpose of this chapter is to briefly sketch the framework used in this study, and to provide a roadmap of the descriptive and analytic chapters that follow.

The U.S. economy is conceptually divisible into six sectors: three "information sectors," two noninformation sectors, and a household sector. The three information sectors produce and distribute all the information goods and services demanded by the economy. The two noninformation sectors supply all the physical or material goods and services whose value or use do not primarily involve information. The household sector supplies labor services and consumes final goods.

The Six Sectors

The primary information sector includes all industries which produce information machines or sell information services on (established) markets. This sector provides the technical infrastructure for a variety of information processing and transmission activities. It also offers information for sale as a commodity. Included here are such diverse industries as computer manufacturing, telecommunications, printing, mass media, advertising, accounting, and education. This is the productive locus of an information based economy. This sector includes eight major classes of industries: (i) the knowledge production and inventive industries; (ii) information distribution and communication industries; (iii) risk management industries including components of finance and insurance; (iv) search and coordination industries, including all market information and advertising vendors; (v) information processing and transmission services, both electronic and nonelectronic; (vi) information goods industries, including information machines; (vii) selected government activities that have direct market analogs in the primary information sector--including the postal service and education, and (viii) support facilities such as office and education buildings.

The primary information sector includes all market transactions of information goods and services. Those portions of the government bureaucracy that provide primary information services are included because they are almost indistinguishable from the market variety. As we shall see in Chapter 4, approximately 25.1% of value added (GNP) originates in the primary sector. The government contributes around 10%, and the private sector countributes 90% of all primary information products. (See Table 4.9.)

The secondary information sector includes most of the public bureaucracy and all of the private bureaucracy. It includes the costs of organizing firms, maintaining markets, developing and transmitting prices, regulating markets, monitoring the firm's behavior and making and enforcing rules.

The public bureaucracy includes all the informational functions of the Federal, State and local governments. Governments perform a myriad of planning, coordinating, deciding, monitoring, regulating and evaluating activities--these are an information overhead cost to the private economy. Those portions of the public bureaucracy which have direct analogs in the primary information sector--such as printing, law and accounting--have been removed from the sector for accounting purposes. Education, one of the largest components transferred into the primary sector, is "sold" as a local public good by state and local governments, with the voter purchasing services as if a market were operating. Only the planning and coordinating activities of governments remain in the secondary information sector.

The private bureaucracy is that portion of every noninformation firm which engages in purely informational activities. It is a direct analog to the public bureaucracy, except its locus is in the private sector. It, too, exacts a high burden on the economy, and consumes a prodigious amount of resources. Although the private bureaucracy produces services similar to the primary information sector (e.g. data processing and library services), we cannot measure the value of each discrete activity. Conceptually, these services are the informational costs of providing a noninformation good. Although the good is sold on markets, the information component is not.

The public productive sector is that portion of Federal, State and local governments which is solely engaged in producing noninformational public and quasi-public goods. This sector includes all highway construction, dam building, maintaining a navy, providing sanitation or transportation services, establishing wildlife preserves and keeping up national parks.

The private productive sector includes all market activities other than those involving information goods and services. This sector is the heart of the traditional economy, including the agriculture, mining and transportation sectors, and most of the construction and manufacturing industries.

Finally, the household sector provides all the labor resources used by the other five sectors of the economy, including workers whose jobs are mostly information oriented and those who are in the agricultural, industrial or traditional service industries. The household sector is also the final consumer for the goods and services sold by the primary information sector and by the private productive sector.

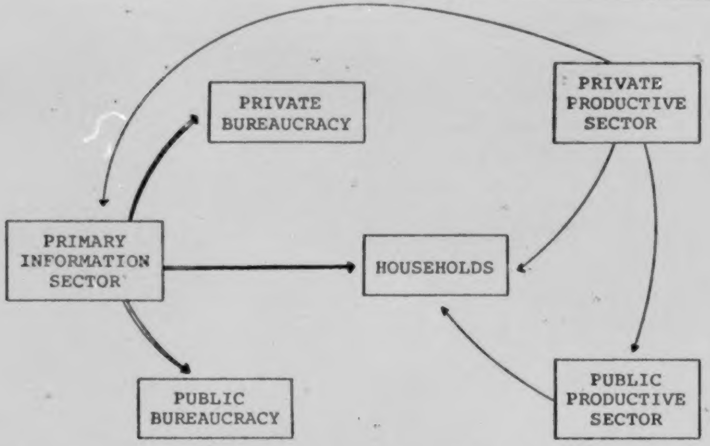
FLOWS BETWEEN THE SIX SECTORS

The six sector scheme involves a variety of market, information, and labor flows. The relationship between the information sectors and the rest of the economy is diagrammed below. This section serves as a brief introduction to the later work on the input-output matrix.

Market Transactions

Goods and services are exchanged in seven major markets, as depicted in Figure 2.1. The flow of information goods and services originates in the primary information sector. For example, the private bureaucracies may purchase computers and telecommunication services; the public bureaucracies may procure private R&D and communications equipment; and households may buy CB radios and calculators.

FIGURE 2.1: FLOW OF GOODS AND SERVICES (MARKET TRANSACTIONS)


PRIVATE BUREAUCRACY
PRIVATE PRODUCTIVE SECTOR
PRIMARY INFORMATION SECTOR
HOUSEHOLDS
PUBLIC BUREAUCRACY
PUBLIC PRODUCTIVE SECTOR

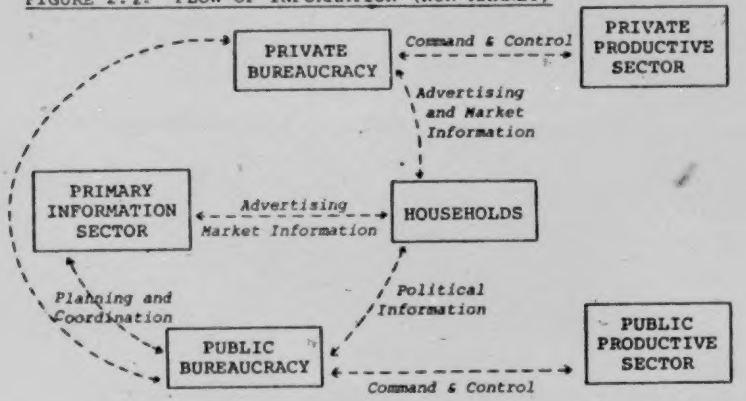
The flow of noninformation goods or services originates in the private productive sector. For example, the primary information sector may purchase sheet metal and copper; the public productive sector might procure concrete and trucks; and households might buy food, housing, clothing and automobiles.

Note that all intermediate (between-firm) transactions are ignored within each major sector. Clearly there exists a large volume of intra-sectoral market transactions, such as computer manufacturers selling to timesharing companies.

Information Flows

Figure 2.2 shows all information flows which are outside the market economy. The primary information industries and the private bureaucracies of noninformation industries exchange a flood of market information with households. The flow to households takes the form of media advertising, circulars, brochures and catalogs. The flow to firms comes indirectly through consumer buying behavior (revealed preference), and in a minor way through market research.

FIGURE 2.2: FLOW OF INFORMATION (NON-MARKET)


PRIVATE BUREAUCRACY
Command & Control
PRIVATE PRODUCTIVE SECTOR
Advertising and Market Information
PRIMARY INFORMATION SECTOR
Advertising
Market Information
HOUSEHOLDS
Planning and Coordination
Political Information
PUBLIC BUREAUCRACY
PUBLIC PRODUCTIVE SECTOR
Command & Control

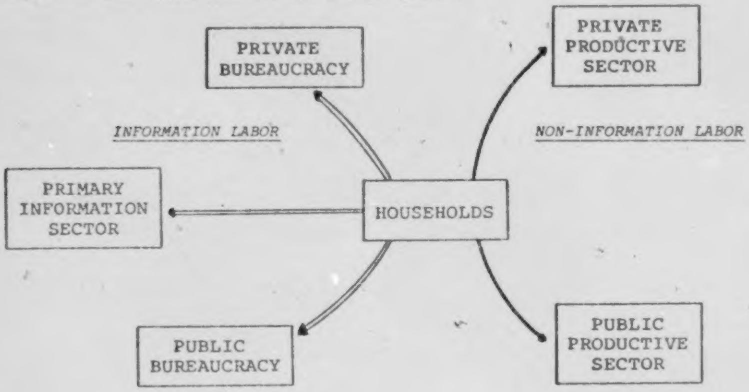
The private and public bureaucracies are the repositories of the planning power in the economy. It is at their direction and bidding that the productive sectors act. They exchange information about production processes, costs, inventories, timing, and so on, and use that information for internal command and control. The two bureaucracies coordinate with each other through a blizzard of forms and reports, and through the revolving door between industry and government. Expertise is exchanged through the purchase of R&D, consulting, and management, and through contracts mandated by laws it is also extracted by regulatory commissions, requested by Congressional committees, offered gratuitously through lobbying, or simply transferred as a result of people changing jobs. Together, they make the rules by which the game is played.

These informational flows are largely nonmarket, although the services produced by the private bureaucracy will be explicitly built into an input-output matrix, in Chapter 10.

Labor Flows

So far, we have accounted the market flows of goods and services, including information (Figure 2.1), and the nonmarket flow of information (Figure 2.2). The last major component of an economic system is the flow of labor. Figure 2.3 shows the flow of labor out of the household sector divided into two streams. Information workers--those whose tasks are primarily involved with producing or manipulating symbols--are employed by the primary information sector and by the two bureaucracies of the secondary information sector. Noninformation workers--those who primarily transform or manipulate physical goods--are hired by the two productive sectors. Implicit in Figure 2.3 is a reverse flow of labor income--employee compensation and proprietors' income is exchanged for labor.

FIGURE 2.3: FLOW OF LABOR (AND INCOME)



PLAN OF THE BOOK

This basic six-sector scheme serves as the organizing framework for all the descriptive and analytic material in the next nine chapters. The plan of the book is as follows:

In Chapter 3, the concept of a "primary information industry" is reduced to an operational definition. Four of the more difficult examples--banks, physicians' offices, real estate, and construction--are explained.

In Appendix 3 (Vol. 2), accompanying the Chapter, the industries that make up the primary information sector are explicated and measured in detail. The thousands of services and manufactured goods that are informational in nature are presented, with a rationale for why they were included or omitted. The Appendix provides a complete data base of the information industries' 1967 share of GNP. A modular approach is taken, so that other researchers can select industries (or parts of industries) that conform to a different conceptual scheme.

In Chapter 4, the primary information industries' share of Gross National Product (GNP) is consolidated into the National Income and Product Accounts. The GNP share is measured in two ways--by sales to final demand and by value added originating in those industries.

Appendix 4 (Vol. 8) gives detailed backup data to the consolidated accounts.

In Chapter 5, national income originating in the primary information sector is estimated in a time series spanning 1929 to 1972. This chapter shows the steady growth of the sector, and serves as a basis of correlating long-term economic growth with activities in the primary industries. It also reveals the sector's sensitivity to macroeconomic cycles.

Appendix 5 (Vol. 8) contains an annual time series (1929-1974) of the primary information sector, plus a discussion on sources and methods. The series is extended to 1974.

In Chapter 6, the primary information sector is built into an input-output matrix. Structurally, the primary matrix collapses the economy into 26 information industries and 82 noninformation industries. The public and private bureaucracies are not explicitly shown. The primary matrix, based on a 507 order detailed matrix, is used in two experiments: (i) reallocating 20% of the defense budget to personal consumption expenditures, and (ii) substituting information capital for noninformation capital, and measuring the impact on total output and employment.

Appendix 6 (Vols. 3, 4, 5) contains the 108 order interindustry transactions matrix, the technology matrix, and the inverse for the 1967 economy. Appendix 6 (Vol. 8) contains the experiments.

In Chapter 7, the U.S. labor force is analyzed in detail. The concept of an "information worker" is introduced, and a 2-sector aggregation of the U.S. workforce (i.e., information and noninformation) is measured between 1860 and 1980. Similarly, a 4-sector time series is presented, showing the rapid emergence of the information work force, and the relative decline of the traditional agriculture, industry and service sectors.

In order to measure the size of the private and public bureaucracies, a detailed picture of the occupational composition of each industry was necessary. We built two industry by occupation matrices showing the employee compensation paid to 422 occupations in the 108 industries used in the input-output matrix. The 1967 matrix is contained in Vol. 6; the 1970 matrix in Vol. 7.

In Chapter 8, the first part of the secondary information sector is discussed. The public bureaucracy is explained conceptually, and presented as a multiservice "information industry." The Federal Government budget is then analyzed using the conceptual framework, and its inputs and outputs are measured over time (1958 to 1970).

Appendix 8 (Vol. 8) contains an expanded typology of the "Federal information industry," in which hundreds of offices, bureaus and programs are sorted by information function. This typology is the basis for the measurements in Chapter 8.

In Chapter 9, the other half of the secondary sector--the private bureaucracies--is defined and measured. Labor income estimated in Chapter 7 is used as the basis for determining the output price of these nonmarket information services. Also, the capital structure and depreciation of all noninformation industries is broken into information and noninformation uses. The consolidated accounts of the secondary sector are built, and integrated into the National Income and Product Accounts structure. A time series of the secondary sector (1929-1974) reveals the rapid growth of the planning sector of the U.S. economy. Preliminary analysis shows that the productivity of the secondary information sector has decreased over time, and a set of implicit price deflators are constructed. These deflators are used to estimate the inflationary effect resulting from productivity losses in the two bureaucracies.

Appendix 9 (Vol. 8) contains the detailed accounts of the secondary information sector at the 190 order.

In Chapter 10, the secondary sector is explicitly built into an input-output matrix. All industries are split apart financially, with the planning and coordinating functions separated from the manufacturing function. The matrix is used to show the informational requirement generated by the purchase of noninformation goods and services. The matrix shows the amount of information that is directly and indirectly "embedded" in items such as food and pharmaceuticals.

Appendix 10 (Vols. 4, 5) contains the secondary matrix at the 190 order, including the technology matrix and its inverse.

CHAPTER THREE

THE PRIMARY INFORMATION SECTOR

> The computer is to the information industry roughly what the central power station is to the electrical industry....[I]nformation, like electricity, is a form of energy.
>
> Peter Drucker, The Age of Discontinuity
> Harper & Row, New York, 1968.

The purpose of this chapter is to explain the framework for building the primary information sector. The conceptual definitions given below are the basis of the detailed industry-by-industry accounting shown in Appendix 3 (Vol. 2). But before we count dollars, we need a clear framework.

Defining a Primary Information Market

There is no single definition of information that embraces all aspects of the primary information sector. It is easier to define information by example than by direct appellation.

The end product of all information service markets is knowledge. An information market enables the consumer to know something that was not known beforehand: to exchange a symbolic experience; to learn or relearn something; to change perception or cognition; to reduce uncertainty; to expand one's range of options; to exercise rational choice; to evaluate decisions; to control a process; to communicate an idea, a fact, or an opinion. An information market may sell topical knowledge with a very short useful life; it may exchange long-lasting knowledge. It may involve a completely specialized or unique configuration of knowledge, useful only to one person in one situation, or it may be public knowledge available to all simultaneously and generally useful in many contexts. It could be extremely costly to produce, or it may involve only very simple processing and transmission approaching zero marginal cost. Information could be a lengthy process spanning a whole lifetime (such as invention), or it could be a burst of data occurring in a millionth of a second.

Table 3.1 shows an overview of the primary information sector. The eight major classes cover hundreds of industries that in some way produce, process, disseminate or transmit knowledge or messages.

Knowledge could be an end in itself; more often knowledge is applied in the acquisition of something material. What one does with knowledge is a matter of taste. Bookies might acquire knowledge about horses to make money to buy things. Veterinarians might acquire knowledge about horses to practice

TABLE 3.1: TYPOLOGY OF PRIMARY INFORMATION SECTOR INDUSTRIES

- KNOWLEDGE PRODUCTION AND INVENTIVE INDUSTRIES
  - R&D and Inventive Industries (private)
  - Private Information Services
- INFORMATION DISTRIBUTION AND COMMUNICATION INDUSTRIES
  - Education
  - Public Information Services
  - Regulated Communication Media
  - Unregulated Communication Media
- RISK MANAGEMENT
  - Insurance Industries (components)
  - Finance Industries (components)
  - Speculative Brokers
- SEARCH AND COORDINATION INDUSTRIES
  - Search and Non-Speculative Brokerage Industries
  - Advertising Industries
  - Non-Market Coordinating Institutions
- INFORMATION PROCESSING AND TRANSMISSION SERVICES
  - Non-Electronic Based Processing
  - Electronic Based Processing
  - Telecommunication Infrastructure
- INFORMATION GOODS INDUSTRIES
  - Non-Electronic Consumption or Intermediate Goods
  - Non-Electronic Investment Goods
  - Electronic Consumption or Intermediate Goods
  - Electronic Investment Goods
- SELECTED GOVERNMENT ACTIVITIES
  - Primary Information Services in the Federal Government
  - Postal Service
  - State and Local Education
- SUPPORT FACILITIES
  - Information Structure Construction and Rental
  - Office Furnishings

medicine. I am completely indifferent as to the motivation for acquiring knowledge, or even to the quality of the knowledge relative to other kinds of knowledge. It does not have to be "good" information to qualify as an information service, nor does it have to be "true." Unfortunately, lies, distortions, and inaccuracies are still information.

A primary information market is established when a technology of information production and distribution is organized by firms, and an exchange price is established. Activities which are closely related to information services--such as manufacturers of information machines--are also members of the primary information markets.

Information as an Activity

Information is by nature a heterogeneous commodity. Education is unlike research and development; computer processing differs from data communication; television is vastly different from books. But these six industries all deliver information services in one form or another, even though their technologies are distinct, they serve distinct markets, and their economic characteristics differ on many dimensions.

Information cannot be collapsed into one sector--like "mining"--but rather the production, processing and distribution of information goods and services should be thought of as an activity.

As a way of motivating the conceptual scheme that underlies our definitions and measurements, consider the "food activity" in the economy. The provision of food involves hundreds of heterogeneous industries. From the agriculture sector we find the farms and agribusinesses that produce basic food commodities. From the manufacturing sector, we find the makers of harvesters, combines, tractors, plows and other artifacts of a modern agricultural economy. We also find the chemical and fertilizer industry, the manufacturer of stoves, freezers, refrigerators, canning equipment and so on. From the construction sector, we might select builders of farmhouses, grain elevators, storage bins, warehouses, supermarkets and restaurants. The service sector includes several industries that are crucial components of the food activity: the food wholesaler and retailer, the preparation firms, and the restaurants and cafeterias. Lastly the transportation sector includes those firms which specialize in moving food by truck or rail.

Together, this group of industries compose an activity. Similarly, the provision of information as an activity involves a large number of closely interrelated but distinct industries. The traditional service sector includes many industries whose sole output is informational: education, R&D, advertising, management consulting, accounting, brokerage and so on. These industries sell information as a commodity; their business is to package information in a form that gains value because it is organized in a useful manner. Carriers of knowledge or information, especially common carriers, are included because their output is strictly and intimately involved in the distribution of information. Carriers do not produce knowledge (except internally), and only sell access to a physical resource. But the resource can be used for nothing other than the transmission of information. Manufacturers of certain machines also are included in the information sector. These machines--computers, television transmitters, instruments, and so on--have only an information processing function to serve. They take information as inputs and, after a mechanical or electronic transformation, produce an information output. The information machines are consumed as intermediate goods by the final producers of information services. Hence, they are ancillary to the service markets. No one values an information machine as an end in itself, but only in its ability to produce a useful output from a useless input. Households buy television sets to transform electromagnetic impulses into visual images. Banks buy computers to organize mountains of paper and masses of disorganized data into useful financial information.

Manufacturers of certain nondurable goods, such as books and magazines, are included. Their products are the physical carriers of symbolic information. The consumer does not buy the physical or material good as an end in itself, but only for its ability to store information in a readily usable form.

Lastly, we account the nation's investment in structures--schools, office buildings, and telephone and telegraph buildings--which serve no purpose other than to house informational activities. These structures are special-purpose "tools" that only support information processing activities.

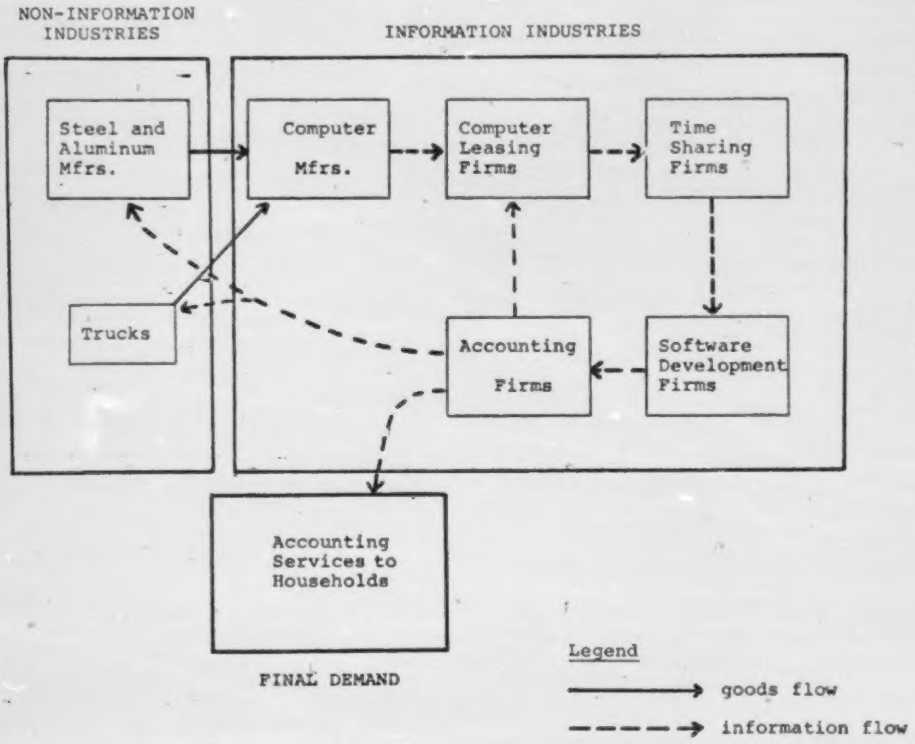
Excluded from the primary information markets are many inputs to the information industries. These inputs come from industries that may be closely associated with information industries but nonetheless do not sell either information goods or services per se. For example, the communication satellite manufacturer is part of the information goods sector, but the delivery rocket and the fuel manufacturers are not, even though the satellite is useless without its noninformation twin.

Conceptually, the good or service must intrinsically convey information or be directly useful in producing, processing, or distributing information to be accounted in the primary sector.

At what point do we stop the intermediate inputs, and exclude them from the primary information sector? Consider the "accounting services marketplace," as shown in Figure 3.1. The final consumer of knowledge or information is the household. In our example, the computer manufacturer, the computer leasing firm, the time-sharing firm, the software development firm are all part of the primary information sector. None sells its services to final demand except the accounting firm (and it too may completely sell its services to other firms). Nonetheless, their value added is measured as part of the primary information sector. The steel and aluminum manufacturers that supply vital materials to the computer industry are outside the primary information sector since their wares are not intrinsically processors or distributors of information.

The myriad goods and services implied by our definition begins to form a coherent structure when we think of "information markets" rather than simply isolating information goods or services. The information industries sell to each other, support each other, and behave as a "sector." Most information markets require a chain of information industries' outputs to deliver the final product: research and development houses need computers; computer manufacturers need research and development; computer time-sharing firms need paper; paper manufacturers buy computer time. The internal structure of the information sector will be

FIGURE 3.1: THE MARKET FOR ACCOUNTING INFORMATION SERVICES


NON-INFORMATION INDUSTRIES
INFORMATION INDUSTRIES
Steel and Aluminum Mfrs.
Computer Mfrs.
Computer Leasing Firms
Time Sharing Firms
Trucks
Accounting Firms
Software Development Firms
Accounting Services to Households
FINAL DEMAND
Legend
goods flow
information flow

discussed in Chapter 6, when we look at the "primary input-output matrix."

Typology of Information Industries

The National Income Accounts (NIA) are not conceptually organized to measure the information industries. To serve as a road map to the detailed description offered in Appendix 3 (Vol. 2), the industries are assembled into a "sectoring scheme" that makes more conceptual and theoretical sense than a simple list.

Table 3.2 shows a more detailed typology organized into "markets for information," "information in markets," and the "information infrastructure."

The thousands of goods and services implied by the typology are discussed in Appendix 3 (Vol. 2). The reader can argue and disagree with our definitions and immediately check the impact on the accounts by referring to the detailed industries. Since there are so many industries, removing one or a few will not appreciably change the size of the sector. The reader is

TABLE 3.2: DETAILED TYPOLOGY OF THE PRIMARY INFORMATION SECTOR

MARKETS FOR INFORMATION

KNOWLEDGE PRODUCTION AND INVENTIVE INDUSTRIES

R&D and Inventive Industries

(7391) Commercial Research and Development Laboratories
(7397) Commercial Testing Laboratories
(8921) Nonprofit Education and Scientific Research Agencies

Private Information Services

(6281) Services Allied with the Exchange of Securities or Commodities
(6611) Combinations of Real Estate, Insurance, Loans, Law Offices
(7392) Business, Management, Administrative, and Consulting Services
(8111) Legal Services
(8911) Engineering and Architectural Services
(8931) Accounting, Auditing, and Bookkeeping Services
(8999) Services, Not Elsewhere Classified

INFORMATION DISTRIBUTION AND COMMUNICATION INDUSTRIES

Education

(8211) Elementary and Secondary Schools
(8221) Colleges, Universities, and Professional Schools
(8222) Junior Colleges and Technical Institutes
(8241) Correspondence Schools
(8242) Vocational Schools, Except Vocational High Schools
(8299) Schools and Educational Services, Not Elsewhere Classified

Public Information Services

(8231) Libraries and Information Centers

Regulated Communication Media

(4832) Radio Broadcasting
(4833) Television Broadcasting

Unregulated Communication Media

(2711) Newspapers: Publishing, Publishing and Printing
(2721) Periodicals: Publishing, Publishing and Printing
(2731) Books: Publishing, Publishing and Printing
(2741) Miscellaneous Publishing
(7351) News Syndicates
(7813) Motion Picture Production, Except for Television
(7814) Motion Picture and Tape Production for Television
(7815) Production of Still and Slide Films
(7816) Motion Picture Film Exchange
(7817) Film or Tape Distribution for Television
(7821) Motion Picture Service Industries
(7922) Theatrical Producers (Except Motion Picture) and Miscellaneous Theatrical Services

INFORMATION IN MARKETS

SEARCH AND COORDINATION INDUSTRIES

Search and Non-Speculative Brokerage Industries

(6052) Foreign Exchange Establishments
(6053) Check Cashing Agencies and Currency Exchanges
(6055) Clearing House Associations
(6161) Loan Correspondents and Brokers
(6231) Security and Commodity Exchanges
(6411) Insurance Agents, Brokers, and Service
(6531) Agents, Brokers, and Managers
(6541) Title Abstract Companies
(7313) Radio, Television, and Publishers' Advertising Representatives
(7321) Consumer Credit Reporting Agencies, Mercantile Reporting Agencies, and Adjustments and Collection Agencies
(7361) Private Employment Agencies
(7398) Temporary Help Supply Services
(7818) Services Allied to Motion Picture Distribution

Advertising Industries

(3993) Signs and Advertising Displays
(7311) Advertising Agencies
(7312) Outdoor Advertising Services
(7319) Miscellaneous Advertising
(7331) Direct Mail Advertising Services

Non-Market Coordinating Institutions

(8611) Business Associations
(8621) Professional Membership Prganizations
(8631) Labor Unions and Similar Labor Organizations
(8651) Political Organizations

RISK MANAGEMENT INDUSTRIES

Insurance Industries (Components Only)

(63) Life, Accident, Fire and Casualty
(636) Title Insurance

Finance Industries (Components Only)

(60) Commercial, Savings Banks & Related Institutions
(61) Credit Institutions

Speculative Brokers (Components Only)

(62) Security Brokers, Commodity Contractors
(63) Patent Owners and Lessors

TABLE 3.2: DETAILED TYPOLOGY OF THE PRIMARY INFORMATION SECTOR - Continued

INFORMATION INFRASTRUCTURE

INFORMATION PROCESSING AND TRANSMISSION SERVICES

Non-Electronic Based Processing

Fixed Costs:

(2753)	Engraving and Plate Printing
(2791)	Typesetting
(2793)	Photoengraving
(2794)	Electrotyping and Stereotyping

Variable Costs:

(2732)	Book Printing
(2751)	Commercial Printing, Except Lithographic
(2752)	Commercial Printing, Lithographic
(2789)	Bookbinding and Related Work
(7221)	Photographic Studios, Including Commercial Photography
(7332)	Blueprinting and Photocopying Services
(7339)	Stenographic Services; and Duplicating Services, Not Elsewhere Classified
(7395)	Photofinishing Laboratories

Electronic Based Processing

(7392)	Pure Data Processing Services

Telecommunication Infrastructure

(4811)	Telephone Communication (Wire or Radio)
(4821)	Telegraph Communication (Wire or Radio)
(4899)	Communication Services, Not Elsewhere Classified

INFORMATION GOODS MANUFACTURING INDUSTRIES

Non-Electronic Consumption or Intermediate Goods

(2621)	Paper Mills, Except Building Paper Mills
(2642)	Envelopes
(2761)	Manifold Business Forms
(2782)	Blankbooks, Loose Leaf Binders and Devices
(2893)	Printing Ink
(2895)	Carbon Black
(3861)	Photographic Equipment and Supplies
(3951)	Pens, Pen Points, Fountain Pens, Ball Point Pens, Mechanical Pencils and Parts
(3952)	Lead Pencils, Crayons, and Artists' Materials
(3953)	Marking Devices
(3955)	Carbon Paper and Ink Ribbons

Non-Electronic Investment Goods

(3554)	Paper Industries Machinery
(3555)	Printing Trades Machinery and Equipment
(3574)	Calculating and Accounting Machines, Except Electronic Computing Equipment
(3576)	Scales and Balances, Except Laboratory
(3579)	Office Machines, Not Elsewhere Classified
(3821)	Mechanical Measuring and Controlling Instruments, Except Automatic Temperature Controls
(3822,	Automatic Temperature Controls
(3821)	Optical Instruments and Lenses

Electronic Consumption or Intermediate Goods

(3652)	Phonograph Records
(3671)	Radio and Television Receiving Type Electron Tubes, Except Cathode Ray
(3672)	Cathode Ray Picture Tubes
(3673)	Transmitting, Industrial and Special Purpose Electron Tubes
(3674)	Semiconductors and Related Devices
(3679)	Electronic Components and Accessories, Not Elsewhere Classified
(5065)	Electronic Parts and Equipment

Electronic Investment Goods

(3573)	Electronic Computing Equipment
(3611)	Electric Measuring Instruments and Test Equipment
(3651)	Radio and Television Receiving Sets, Except Communication Types
(3661)	Telephone and Telegraph Apparatus
(3662)	Radio and Television Transmitting, Signalling, and Detection Equipment and Apparatus
(3693)	Radiographic X-ray, Fluoroscopic X-ray, Therapeutic X-ray, and other X-ray Apparatus and Tubes; Electromedical and Electrotherapeutic Apparatus
(3811)	Engineering, Laboratory, and Scientific and Research Instruments and Associated Equipment

WHOLESALE AND RETAIL TRADE IN INFORMATION GOODS

Household Investment Goods

(5732)	Radio and Television Stores
(5996)	Camera and Photographic Supply Sotres
	Hand Calculators

Consumption Goods

(5942)	Book Stores
(5994)	News Dealers and Newsstands
(7832)	Motion Picture Theaters, Except Drive-in
(7833)	Drive-in Motion Picture Theaters

SUPPORT FACILITIES FOR INFORMATIONAL ACTIVITIES

(15)	Contract Construction of Office, School, Communications Buildings
(65)	Rentals of Information Structures
(25)	Furnishings for Office Buildings

encouraged to turn to Appendix 3 (Vol. 2), since much of the careful explication is given in the context of describing the detailed industries. Each industry's share of GNP is measured both on the product (final demand) and income (value added) side of the account.

The government's share of GNP is accounted in two ways. On the product (final demand) side, the share includes only the government purchases of information goods and services from the private economy. On the income (value added) side, we include only the compensation of those employees engaged in performing services that have direct analogs in the primary information sector, e.g., printing, legal services, telecommunications, etc. A complete description of the Federal Government is given in Chapter 8.

SOME INSTRUCTIVE EXAMPLES

It is clear that libraries and palm readers sell information services; and it is clear that plumbers and restaurants sell noninformation services. But there are a variety of industries whose output is conceptually less clear. I shall briefly introduce four industries--finance, physicians' offices, real estate, and construction--as exemplars of how we view "information." A complete description of each primary information industry appears in Appendix 3 (Vol. 2).

Example 1: Finance and Insurance

The financial industries are fundamentally organized around intermediation--the brokerage of money and financial assets. Money itself is nothing more than a symbolic store of value, carrying information as to the holder's claim on assets. When money is deposited in a time (saving) or demand (checking) account, it completely loses its sense of being a "commodity," and instead assumes the form of pure information: it is converted into information, stored in computer-driven data banks. Money in this form is exchanged between banks over a telecommunications network, where only information flows between the vendors of financial services. An electronc funds transfer system is a pure information medium for carrying out financial transactions.

The business of finance provides many informational services: some earn an explicit income, and others are not explicitly charged. For example, a bank may provide the following explicitly charged services:

Transactions charges on demand deposit
Transactions charges on money orders
Transactions charges on trust accounts
Transactions charges on travelers' checks
Transactions charges on funds transfers

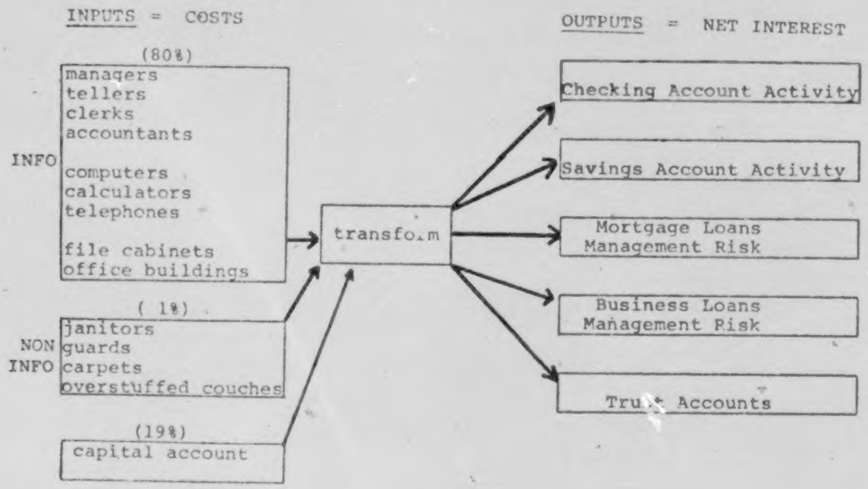
In addition, there are a variety of informational services which are not explicitly charged, but rather are paid out of the net interest income, for example: .

Analysis of borowers' risk
Analysis of investment portfolio
Analysis of foreign exchange rates
Analysis of macroeconomic development
Internal management and bookkeeping
Legal, political, and promotional activities
Transactions with the Federal Reserve

The Banking industry's output is defined as the sum of net interest plus service charges. As shown in Appendix 3 (Vol. 2), the entire output just equals the expenses of producing, processing, and transmitting financial information. About 81% of the industry output is used in providing information services, and 19% represents the cost of capital.

Diagrammatically, a bank can be represented as follows:

FIGURE 3.2: A BANK


INPUTS = COSTS
(80%)
managers
tellers
clerks
accountants
INFO
computers
calculators
telephones
file cabinets
office buildings
(1%)
janitors
NON INFO
guards
carpets
overstuffed couches
(19%)
capital account
transform
OUTPUTS = NET INTEREST
Checking Account Activity
Savings Account Activity
Mortgage Loans Management Risk
Business Loans Management Risk
Trust Accounts

The outputs are all informational and the inputs are predominantly information. When a consumer pays for commodities by check, the shopkeeper is secure in the knowledge that a transfer of funds from one account to another will eventually take place. The consumer does not only pay for the purchased good, but also for some transmittal of information. This information exchange is costly to produce, and banks often levy explicit service charges to perform the information services. Also, when a bank loans money to a household or business, part of the net interest pays for extensive analysis and diagnosis of the loan opportunity. These charges are often implicit and, as we show in Appendix 3 (Vol. 2), are covered by net interest.

A bank, viewed as a firm, purchases various inputs to a multiple-output production function. This view was adopted in a Federal Research Board of Boston staff paper produced by Bell and Murphy.[1] A bank is seen as a factory which purchases information machines (computers and calculators), buys information services from other firms (telecommunications lines, terminals), hires production workers (clerks, tellers, machine operators), and produces a variety of financial services. Bell and Murphy state,

> "The servicing of demand deposit accounts is a distinct 'production line operation.' Associated with this function are the receiving and processing of checks, involving sorting, tabulating, and many other detailed operations. Tellers, bookkeeping machine operators, and many kinds of equipment are employed to produce a demand deposit account."

Their analysis of over 20 commercial banks shows the following cost breakdowns on the many services provided by financial intermediaries:

TABLE 3.3: FUNCTIONAL COST AND EMPLOYMENT FOR THE TYPICAL COMMERCIAL BANK

FUNCTION	PERCENT OF TOTAL COST	PERCENT OF TOTAL EMPLOYEES
Explicit Services		
Demand deposits	33.7	51.1
Time deposits	6.2	6.6
Safe deposits	1.3	1.7
Analysis & Diagnosis		
Managing real estate loans	4.2	3.8
Managing installment loans	12.8	13.1
Managing business loans	6.8	6.6
Managing securities	1.3	0.8
Trust department	5.3	5.4
Business development	4.2	1.9
Administration (overhead)	10.5	---[a]
Other		
Occupancy and maintenance	13.7	9.0[a]

[a] Occupancy and administration combined.

Source: Bell and Murphy, op. cit.

The National Income Accounts define the Banking industry's output as the sum of two items: (i) charges levied for explicit services performed by the bank such as checking account charges, money order charges, and so on; and (ii) an "imputed service charge" for financial services performed for the customer as "services furnished without payment by financial intermediaries."

Banks are conceived as paying to their customers an "imputed interest" on checking account deposits plus an imputed interest higher than the nominal rate of interest on time deposits. That is, the banks are imputed to "pay out" to consumers much more in interest payments than is actually paid on passbook accounts. However, banks are also conceived as receiving from customers an "imputed service charge" for a variety of services performed without an explicit charge. In the accounts, these two payments exactly cancel out.

A detailed examination of the banking industry's accounts (presented in Appendix 3 (Vol. 2)) reveals that the direct information costs incurred in providing banking services equal net interest. The entire output is "produced" by informational inputs. The explicit service charges are earned on demand deposits, checking transactions, funds transfers, and trust account activity--pure information services. The implicit service charges are earned on the analytic and diagnostic activities. Together, these represent the bank's output. The implicit service charges can be broken into operating expenses (e.g., information workers, machines, and buildings) plus the expenses of maintaining the capital account. The explicit service charges are assumed to just cover the actual cost of providing the services. Hence, the summary data shown in Table 3.4 can be rearranged to show the ratio of inputs to outputs.

TABLE 3.4: SUMMARY OF BANKING INDUSTRY ACCOUNTS

		($ Millions, 1967)	
	NATIONAL INCOME ACCOUNTS	FDIC	INFORMATION
S = Explicit Service Charges	2,628	2,628	2,628
Implicit Service Charges ("services furnished without payment by intermediaries")	11,727	---	---
Net Interest	---	11,507	---
O = Operating Expenses Incurred in Providing Information Services	---	---	8,907
P_k = Expenses of Maintaining the Capital Account (estimated)	---	---	2,600
Statistical Correction	---	220	220
Y = TOTAL OUTPUT	14,355	14,355	14,355

The accounting identity allocating the banking industry to the primary information sector reads as follows:

$$\text{proration} = \frac{S + O + P_k}{Y} = \frac{\text{Information inputs}}{\text{Output}} = 1.0$$

where, S: explicit charges for information services

O: informational operating expenses = implicit service charges

P_k: cost of the capital account, $r(K_t)$ where r is approximately 5.7% and K_t is the adjusted capital account

Y: NIA concept of output = service charges plus net interest.

The entire bank industry's output is allocated as an information service. The output--net interest--is completely consumed in providing information services.

Insurance

The Insurance industry can be conceptualized in comparable terms. The industry performs three functions: (i) a diagnostic, analytic activity in its underwriting and investment activities; (ii) a processing function in its actuarial and record-keeping activities; and (iii) a risk-pooling function derived from the phenomenon that individuals are risk averse. In this third case, the insurance firm sells a commodity called "certainty" to risk-averse individuals. The customer buys a measure of utility, or benefit, derived from the foreknowledge that should any contractually specified undesirable event occur, the customer (or victim) will be compensated by the insurance firm. The individual makes a judgment regarding the size of the damage, or disutility, that would result if a certain undesirable event should occur, and maps that judgment through some private probability estimate onto a dollar scale. The price of the insurance, or "security," should just equal, at the margin, the disutility of the event's occurrence. The contract covering the individual against a sequence of contingencies is a commodity called "certainty," and its behavior in a market context is similar to any other commodity. The buyer and seller are free to specify how large a bundle is to be transacted (i.e., how many different contingencies are included), and make a determination as to the bundle's worth. Equating the utility of owning the commodity "certainty" with its price is the customer's problem; and equating the expected value of payout with the price is the seller's problem.

The insurance firm, in order to sell its comodity, must engage in a large amount of diagnostic, analytical, and actuarial work. Around 83% of the Insurance industry's costs originate with such informational activities. The remaining 17% of the industry's costs are attributable to maintenance of the capital account. Again, total informational costs completely explain total income.

Stock and Commodity Brokers

The brokerage industries, where the agents do not carry risk in the same sense as an insurance firm, are seen as "search" industries. Their market opportunity arises from uncertainty regarding the price of stocks, bonds, and commodities--coupled with the fact that information costs are subject to a budget constraint on the individual's time. Acquiring information is costly, and not acquiring information is also costly. If the search specialist can economize on search costs, consumers can be induced to buy search activities rather than engage in those activities on an individual basis. Thus, both the cause of the market's existence and the industry's output are informational in nature. The only component which is not informational is the occasional capital gain (or loss) incurred when brokers buy and sell on their own account. Around 76% of the stock and commodity broker's income is generated by the search function, while 24% is generated by appreciation on the brokerage house's inventory of assets.

Occupational Structure of Finance Industries

Another way of estimating the informational share of the Finance and Insurance industries is by examining the occupational structure--asking who is doing what, for how much money.

In 1967, the Finance and Insurance industry paid $18,988 million in employee compensation; $18,505 million was paid to information workers and $483 million was paid to noninformation workers. The wage bill can be divided into 422 occupations (by using the Industry by Occupation wage matrix). Table 3.5 summarizes the largest occupational groups.

Table 3.5 shows that almost all the employee compensation was paid to information workers. This result supports the idea that finance and insurance primarily provide information services.

TABLE 3.5: BREAKDOWN OF EMPLOYEE COMPENSATION IN FINANCE & INSURANCE

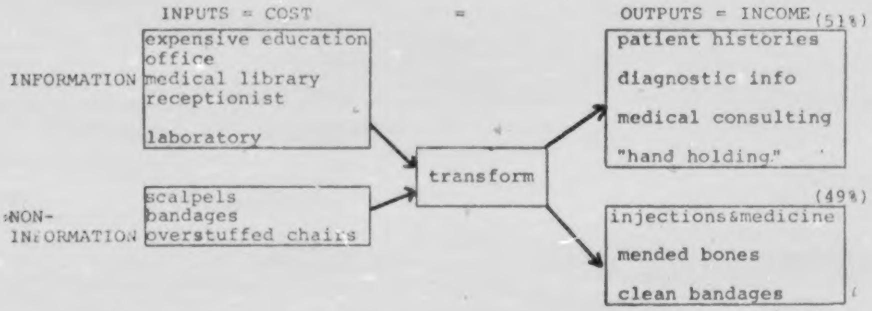
	EMPLOYEE COMPENSATION ($ Millions, 1967)
Providing a transaction service	5,833
Insurance agents	3,484
Stock and bond brokers	1,150
Bank tellers	1,199
Internal information processing	5,329
Accountants	390
Secretaries	1,273
Typists	546
Bookkeepers	701
Statistical clerks	241
Miscellaneous clerical	635
Other clerical & machine operators	1,543
Analysis and diagnosis	7,343
Bank managers	3,556
Other managers	1,360
Estimators and investigators	292
Insurance adjustors	734
Other	1,401
Non-Information	483
Janitors and cleaners	147
Guards and watchmen	62
All others	274

Source: Industry by Occupation wage matrix, computed from BLS Industry by Occupation matrix, Census data, BLS data and unpublished data. See Appendix 7 (Vol. 6).

Example 2: The Medical Industry

Consider a physician's office, which can be diagrammatically represented as follows:

FIGURE 3.3: A PHYSICIAN'S OFFICE


INPUTS = COST
=
OUTPUTS = INCOME
(51%)
INFORMATION
expensive education
office
medical library
receptionist
laboratory
NON-INFORMATION
scalpels
bandages
overstuffed chairs
transform
patient histories
diagnostic info
medical consulting
"hand holding"
(49%)
injections&medicine
mended bones
clean bandages

The physician, like the bank, uses both informational and noninformational inputs. But unlike the bank, the inputs are transformed into both information and noninformational outputs.

The Medical industry is divided in the national accounts into three smaller industries: (i) doctors and dentists who practice in their offices, a $13.7 billion industry in 1967; (ii) other medical and health services, including veterinarians, medical laboratories, and sanitoria, a $4.4 billion industry; and (iii) hospitals, with an output of $10.8 billion. We shall only consider portions of the physicians' offices and medical labs as informational and completely eliminate hospitals.

Hospitals and dentists' offices were summarily excluded on the grounds that they are mostly engaged in the provision of a "craft" or personal service, with the informational activities being ancillary in nature. A hospital's primary purpose is a personal service--albeit with strong informational component. Most major medical centers connected with universities perform a vast amount of "knowledge production" in the form of medical research and diagnosis; hence eliminating hospitals as an "information industry" severely understates the size of the sector. Chapter 9, containing a discussion on the secondary information sector, will partially account for the in-house knowledge activities of hospitals, but the accounting will understate the true portion of hospital income earned on informational activities. For example, a recent time-budget study[3], conducted by a Stanford research team found that around 60% of a nurse's time is spent in such obvious informational activities as "writing in the file," reading doctor's instructions, or gathering information on a patient's temperature, blood pressure, and so on. The remaining 40% of the time was spent on actual patient care, i.e., feeding, clothing, changing bandages, administering medicine, tending to bedding needs, and so on. In addition, every hospital supports extensive diagnostic facilities, laboratories, training, and administrative facilities. The latter, involving the clerical and financial processing, is almost entirely an information processing function.

The health care activity is a composite of various tasks, some information producing, processing, or distributing in nature, and others decidely in the "craft" or personal service tradition. The typology in Table 3.6 illustrates the conceptual scheme underlying the analysis.

TABLE 3.6: TYPOLOGY OF INFORMATION IN THE HEALTH INDUSTRY

Craft or personal service	
Surgery	Administering medicine
Setting broken bones	Fitting IUD's
Cleaning wounds	Giving physical therapy
Applying bandages	Hospital feeding, bathing etc
Information producing or receiving	
Research	Taking histories
Diagnosis	Consulting with other doctors
Information processing	
Administrative information:	
Clerical	
Accounting	
Insurance forms	
Research and diagnostic	
Computer processing	
Instrument-controlled processing	
Information distribution or giving	
Diet counseling	Patient education
Preventative health care education	Post-surgical care counseling

The only component of the Medical industry allocated to the primary information sector was a portion of the "physician's office." To allocate the portion of physician's income between information and noninformation activities, three time budget studies were used. The office-based physician's use of time has been studied by several researchers, and offers one of the most comprehensive sources of time-budget analysis of any occupation.[4] Appendix 3 (Vol. 2) contains a detailed report on how the time budgets were analyzed. In short, about 69% of a physician's time is spent in a variety of information tasks. Table 3.7 shows that more than half of a physician's time is spent in the office, seeing patients; about 85% of office time is used in giving or receiving information.

As an afterword, I would like to salute the casual manner in which Machlup treated the medical industry. After relying on five separate data bases, which cost (in the aggregate) close to $500,000 to develop, I allocated of 50.85% of the medical industry as informational in nature. Machlup on the other hand, reports without elaboration,

> "We are interested only in the production of knowledge or, in this case, in the sale of medical advice, prescriptions and information... however, no breakdown of receipts is available... We have decided that only half of the payments to physicians and surgeons are for advice and information."

Close enough.

Example 3: The Real Estate Industry

One of the many outputs of the industry is rental of office space. Office buildings are used for one purpose--to support the informational needs of the private and public bureaucracies. They are the structural repositories of work-time chatter, of meetings, of report and letter writing, of research, of back-room deals and front-room hyperbole. Most of what goes on inside an office building is informational. (In our accounts, the cafeterias, garages, retail shops and warehouses in office buildings are excluded.) A noninformation firm may rent an office building as an input, just as it might rent a computer. The rentals of office space as a portion of total real estate output is around 38%. This percentage is used to prorate the real estate industry's value added into information and noninformation accounts.

The real estate industry also includes the search fees and commissions earned by brokers. These search fees are classic information services since only knowledge about markets is sold to the consumer. Other search-type industries include employment agencies, wholesale agents, stock brokers, and commodity brokers.

TABLE 3.7:

AVERAGE NUMBER OF HOURS PER WEEK ALLOCATED TO DIFFERENT ACTIVITIES BY TYPE OF PROFESSION

Weighted by: (a) participation rate of physicians; (b) distribution of physicians to different professional specialties; and (c) distribution of net income to each specialty. This table is a summary of five surveys using comparable data.

(Hours per Week)

PROFESSIONAL ACTIVITY	G.P.	INTERNIST	SURGEON	OBG	PED	AVG	INFO
1. Seeing office patients	32.6	30.3	16.3	30.0	42.2	30.3	25.9
2. Hospital rounds and consultations	9.6	15.9	16.6	10.6	11.3	12.8	6.4
3. In operating, delivery, labor rooms	3.0	0	13.7	16.2	0.4	6.7	0
4. Professional reading and writing	3.7	4.0	3.6	3.6	4.4	3.9	3.9
5. House calls	2.4	1.9	0.6	0	0.8	1.1	0
6. Paper work, except insurance	1.9	2.4	2.3	1.7	1.3	1.9	1.9
7. Teaching in hospital or medical school	0.1	1.2	0.9	0.9	1.1	0.8	0 8
8. Hospital and other practice-connected meetings	1.8	2.6	2.6	2.5	2.5	2.4	2.4
9. Working on insurance forms	1.4	1.2	2.1	1.0	1.1	1.4	1.4
10. Other professional activities	0.5	1.4	0.9	0.4	1.2	0.9	0
TOTAL	57.0	61.0	59.6	66.9	66.3	62.2	42.7

INFORMATION AS A PORTION OF TOTAL TIME SPENT (INFO/AVERAGE) = .6865

Source: For (a): Medical Economics, op.cit., December 6, 1971, pp. 79-87
For (b): Medical Economics, November 11, 1974, p. 240, based on a survey conducted by Clark-O'Neill Inc. and the A.M.A. comparing the survey sample of 11,235 with the universe statistics.
For (c): Medical Economics, ibid. p. 238.

The two major data bases on time budgets are:

(i) Department of Health, Education and Welfare, National Ambulatory Medical Care Survey, Background and Methodology, DHEW Publication No. (hra) 74-1335.

(ii) See Contract No. HEW-OS-72-183, with support from the Robert Wood Johnson Foundation. The relevant reports are: Golladay, Hansen, Smith et al., "The Empirical Study of Efficient Health Manpower Utilization", University of Wisconsin, May 1975; Smith, Miller and Golladay, "An Analysis of the Optimal Use of Inputs in the Production of Medical Services," Journal of Human Resources, Vol. VII, No. 2, Spring 1972.

Another portion of the real estate industry includes sales of royalties, copyrights, and patents. These transactions are payments for intellectual property (as opposed to real property), and are surrogates for the sale of knowledge. They are accounted as part of the information sector.

Most of the real estate industry is noninformationl, including rentals on factories, warehouses, farms, private residences, and retail establishments. The industry report in Appendix 3 (Vol. 2) shows a detailed accounting of how real estate was divided, with 21% allocated to information and 79% to noninformation.

Example 4: Construction

About 15% of the Construction industry was allocated to the primary information sector. Education buildings are an obvious component, since they are used (almost) exclusively for informational purposes. Telephone and telegraph buildings are also obvious candidates. Office buildings were also included, with all noninformation uses (e.g., garages, retail stores, warehouse space) removed. Selected military buildings, such as computer centers and communication facilities, were also included.

One of the more interesting components of construction is gas and oil exploration. These services are a clear case of "information for sale" where the quality of the product is unknown until well after delivery. The expected value of drilling a dry well without foreknowledge versus the expected value of drilling a well with the aid of a forecasting service (profits of the well less fixed cost of the information service) gives the break-even value of the exploration service. Couched in this manner, the value of the exploration service can be determined using the decision analysis method. However, there exist severe incentive problems in the production of this particular sort of information. Consider the incentives of an entrepreneur who owns (or intends to bid on) a drilling franchise. If the oil field is larger that one plot (i.e., spans a number of plots, each owned by a different entrepreneur), then the information bought by the first firm becomes a "public good" to the other firms since they could each receive costless information regarding the expected yield of the commonly drilled oil field. Should the first firm hide the information from the others? This solution would be both impractical and inefficient. It would be impractical because the firm which bought the information would be voluntarily enjoined from acting on its inside knowledge lest its very actions serve as a signal to the other firms. That is, without revealing the information per se, the firm will have revealed enough of the information by its observable actions to undermine the secrecy strategy. The other firms, can, by simple observation, gather intelligence inductively. The knowledgeable firm would inform the others in the following ways: where to drill (by the location of the rig), how much to drill (by the size and type of the capital equipment brought in), and possibly the expected value of the well (by related financial behavior, such as attempting to buy neighboring franchises, actions on the capital markets, the behavior of insider trading, etc.). The strategy would be inefficient, in addition, since each firm would have to duplicate the information-gathering efforts already purchased by the first firm--information which could be shared by all.

In the sense that exploration is a public goods problem; disincentives in its private supply might be expected. Each firm would perceive its marginal private cost as exceeding its private benefit in cases where resources were commonly held. Only if one firm became a monopolist would the full incentive to produce private information be appreciated. Hence, society will experience a less than optimal amount of exploration unless some public subsidy were forthcoming or unless a monopoly were granted. The existence of the U.S. Geological Survey of the Department of the Interior serves precisely as a public subsidy to exploration. The provision of detailed resource maps, often augmented by either special studies (e.g., satellite exploration) or industry-sponsored research (e.g., American Petroleum Institute) reduce the private cost of exploration as an effort to induce the private collection of what is normally a public good. It is for this reason also that the exploration costs are understated in the National Accounts--the output of SIC 1382 ignores three major sources of funds: Federal support through institutions like the Geological Survey; private industry-wide funds, commonly shared; and within-firm exploration services that are not purchased from an "information specialist."

The procedure outlined in Chapter 9 will partially account for the within-firm production and consumption of information services, one of which (in the Petroleum industry) is clearly the exploration services. From an accounting standpoint, it is quite difficult to identify the joint and unique costs of performing the exploration. That is, a drill bit may be jointly used for both the exploration effort and the actual drilling effort; similarly, an airplane may be used for the transportation of executives and for aerial exploration. Hence, a significant understatement of the information-gathering activities within oil, natural gas, and mining firms is expected. (There exists no unique SIC for the exploration services sold to mining firms; all such information gathering is presumed to occur within the firm.)

The exploration services are capitalized by the purchasing firm; hence, the entire output of the industry is sold to a final demand component--gross private domestic capital formation. This is one of very few instances where an information service is capitalized. Research and development, installation fees on equipment, royalties and copyrights, software services developed in house, commission on structures are some of the others.

These four examples show that the information activity is composed of many heterogeneous pieces. The unifying definition is that the goods and services that make up the primary sector must be fundamentally valued for their information producing, processing, or distributing characteristics. If the informational aspect is ancillary to the noninformational aspect, the good or service is eliminated.

FOOTNOTES

[1] F.W. Bell and N.B. Murphy, *Economies of Scale in Commercial Banking*, Federal Reserve Bank of Boston, 1967.

[2] This convention is explained in *Readings and Methods of National Income Statistics*, U.S. Department of Commerce, pp. 79-83.

[3] E. Sondik, unpublished paper, Department of Engineering-Economic Systems, Stanford University, 1974.

[4] See Massey and Whitehead, *Measurement of Time Spent Educating Patients in Physician's Office*, Report No. 2796; *Evaluation of an Automated Medical History in Office Practice*, Report No. 2741; *Development and Deployment of Computer Aids in the Physician's Office*, Report No. 2512; *An Assessment of the Utility of Computer Aids in the Physician's Office*, Report No. 3096. Bolt, Beranek and Newman, Boston, Mass. Supported by Contract No. HSM 110-71-244 from the Division of Health Care Information Systems and Technology, U.S. Public Health Service and the National Center for Health Services Research, U.S. Department of Health, Education and Welfare.

CHAPTER FOUR

CONSOLIDATED ACCOUNTS OF THE PRIMARY INFORMATION SECTOR

The purpose of this chapter is to consolidate the detailed industry data presented in Appendix 3 (Vol. 2) and to formally introduce a set of National Income and Produce Accounts for the primary information sector.

Appendix 3 (Vol. 2) contains descriptions of all the industries included in the primary information sector. Care was taken to insure that all prorations and allocations are consistent with national income accounting concepts, definitions, and methods. Hence, a simple upward aggregation of the industry detail immediately yields a consistent set of summary accounts. They are consistent in two senses: first, they are fully reconciled internally (i.e., within the information sector) and with the Input-Output matrix to be presented in Chapter 6; second, they are fully reconciled with other published national data, such as the National Income and Product Accounts, and the economic and population censuses.

Five summary and two detailed accounts are presented. The accounts exactly mirror the national accounts format as published by the Department of Commerce.[1] This decision was made to facilitate direct comparison with the conventional sectoring scheme.

Table 4.4, "Gross National Product by Final Demand Sector," shows the final purchases of information goods and services by the four final demand sectors--personal consumption, gross private investment, net exports, and government purchases.

Table 4.5, "Gross National Product by Major Type of Product and Purchase," displays the same final demand data as in Table 4.4 except the categories are reversed. This table shows the relative size of the consuming sector for each class of good or service.

Table 4.6 shows the "National Income by Type of Income." It provides a breakdown of national income by employee compensation, proprietors' earnings and corporate profits.

Table 4.8 shows "Gross Product Originating by Industry," and is a summation of five value added components--employee compensation, net interest, capital consumption allowances, indirect business taxes and profit type income. The table is broken down by sector.

Table 4.9, "Gross Product by Sector," is a summary of the detailed value-added components. Industries are aggregated up to the "major sector" level and components of value added are shown.

Two detailed tables, 4.10 and 4.11, show the final demand and value-added components at the 2-digit SIC level.

These seven tables constitute the full set of consolidated accounts for the primary information sector in 1967.

Comparison to the Machlup Study

Most of the basic insights and concepts motivating this study were established in Fritz Machlup's groundbreaking book on the "knowledge industries." His book, analyzing the 1958 economy in detail, stands as an enormously valuable contribution. It provides an empirical backdrop to subsequent work by Daniel Bell, Peter Drucker, and others. There exist, however, three significant methodological differences between his approach and the one set forth in this work, and they should be aired in advance.

First, Machlup's accounting scheme innovated rather liberally on the National Income Accounts concepts and practices, whereas this study does not. Second, his work includes an admixture of both "primary" and "secondary" type activities, whereas this study keeps them distinct. Third, a variant of final demand is used by Machlup as a measure of the knowledge industry size, whereas this study uses primarily the value added approach but reports both sets of figures. The three differences are discussed below.

(1) National Accounts Concepts and Definitions

Machlup's basic accounting scheme begins with five major classes of knowledge production, processing, and distribution, and 30 industries that are classified into: (i) education, (ii) research and development, (iii) media of communication, (iv) information machines, and (v) information services. In pursuing the size of these five activities, many "adjustments" to the conventional notion of Gross National Product are made. For example, education in the home (as the forgone wages of nonworking mothers) is explicitly accounted, as are implicit costs (such as implicit rentals on school buildings), education in the church and the like. Although Machlup is consistent in adjusting the total GNP for 1958 by the amount of these additions, the methodology is not comparable to standard income accounting concepts.

Also, Machlup includes a variety of current account items as part of the "total knowledge-production value," whereas the standard measure of final demand excludes all current costs. These distinctions are carefully documented. For example, businesses purchased $2,503 in advertising space from the newspaper industry as an intermediate product--hence that amount was not included in official final demand estimates. Machlup treats the advertising purchases as an investment made by the firm, as if it were investing in structures or machines, and hence transfers the amount into final demand. I agree in spirit that advertising is an investment, and its purpose is either to capture market share, defend a market share, or induce new demand in an expanding market. However, it represents a deviation from the concepts and definitions of national income accounting.

A choice point was reached early in the research. On the one hand, many deficiencies exist in the notion of GNP as a true measure of economic wealth. For example, recent attempts to measure Net Economic Welfare address the GNP concept's failure to distinguish economic goods from bads. On the other hand, GNP measurements are standardized and accepted, both across time and by international agreement.

The choice was whether formally to introduce an information sector into the conventional national accounts structure; or whether to innovate both by introducing a new sector and by redefining the very concept of GNP.

The decision was reached with caution--that the concept of an information sector was sufficiently new that a simultaneous overhaul of the GNP scheme would confuse and obfuscate more than it would help. When the economics profession agrees on a new measure of Gross National Welfare rather than Gross National Product, the information sector can be redefined with all the other major sectors.[2] But until that revision occurs, I chose to adhere strictly to the accepted national accounting practices.

(2) Admixture of Primary and Secondary

Several adjustments that Machlup made to the "final demand" accounts were early insights regarding the secondary information sector's existence. For example, "training on the job" is clearly a secondary information output, as is research and development financed and conducted within noninformation firms. Machlup's discussion of the government as a knowledge industry, with outputs such as "regulation of industry" and "international affairs information exchange services" is clearly a precursor of Chapter 8. However, the primary sector has the distinction of representing only recognizable market transactions. All nonmarket processes are relegated to the secondary information sector of Chapters 9 and 10.

The primary and secondary activities are quite distinct. In some cases, markets for information are clear and measurable. In other cases, markets for information have not or cannot be formed and the entire activity occurs in a nonmarket context. An example of a market that cannot form is foreign intelligence. All purchases and sales of intelligence-type information occur in an "informal" market setting. Industrial espionage is a similar informal information market (no SIC code) in the private sector. And detective agencies are the formal market (SIC code 7393) analogs involving the production and exchange of intelligence information.

Confounding nonmarket information activities with information exchanged in markets needlessly strains the intuitive appeal of this type of work. A much more straightforward method of measuring the value of secondary "knowledge production" is available if one resorts to using the income side of the accounts rather than attempting to adjust the product side. More on that in the next section.

TABLE 4.1: COMPARISON OF MACHLUP APPROACH WITH THE PRIMARY INFORMATION SECTOR FINAL DEMAND (USING NATIONAL ACCOUNTS CONCEPTS & DEFINITIONS)

INDUSTRY	MACHLUP[1]	NIA[2]
EDUCATION	60,194	21,232
Education in the home	4,432	0
Training on the job	3,054	0
Education in the church	2,467	0
Education in armed forces	3,410	0
Elementary & secondary		
Monetary expenditures	16,054	16,054
Implicit costs	17,285	0
Colleges & universities		
Monetary expenditures	4,443	4,443
Implicit costs	8,314	0
Commercial, vocational	253	253
Federal programs, nec	342	342
Public libraries	140	140
RESEARCH AND DEVELOPMENT	10,990	7,330
Basic research	1,016	741
Applied research	9,974	6,589
MEDIA OF COMMUNICATION	37,563	18,994
Printing & publishing		
Books and pamphlets	1,595	1,552
Periodicals	1,811	780
Newspapers	3,956	1,453
Stationary & office supplies	1,852	952
Commercial printing	2,879	592
Photography	1,600	1,600
Phonography	1,035	1,035
Stage, podium & screen		
Theatre and concerts	313	0
Spectator sports	255	0
Motion pictures	1,172	1,172
Radio and television		
Radio station revenue	523	0
Television station revenue	1,030	0
Radio & TV set repairs	1,982	1,982
Radio & TV investments	0	0
Telecommunications media		
Telephone	7,642	3,300
Telegraph	318	137
Postal Service	3,000	900
Other advertising	5,000	3,539
Conventions	1,600	0
INFORMATION MACHINES	8,922	8,732
Printing trades machinery	350	350
Musical instruments	190	0
Motion picture equipment	147	147
Telephone & telegraph equipment	1,200	1,200
Signaling devices	200	200
Measuring & controlling instruments	4,968	4,968
Typewriters	272	272
Electronic computers	332	332
Other office machines	937	937
Office machine parts	326	326
INFORMATION SERVICES	15,542	15,567
Professional services		
Legal	3,025	1,507
Engineering & architectural	1,978	0
Accounting & auditing	1,138	0
Medical (excluding surgical)	2,083	2,083
Joint with financial services		
Check deposit banking	n/a	n/a
Securities brokers	647	575
Insurance agents	2,173	2,173
Real estate agents	n/a	n/a
Wholesale agents	1,229	1,229
Miscellaneous business services	1,714	0
Government services		
Federal	1,555	8,000[a]
State and local		---[c]
TOTAL KNOWLEDGE PRODUCTION	$133,211[b]	$ 71,855
% OF GNP	29%	16%

---

[1] Machlup's "Knowledge industries, total value", 1958

[2] National Income Accounts Concept of primary information sector final demand.

[a] The Federal, state and local governments are final demand sectors. Their purchases include goods, services and wages. The $ 8 billion represents only wages of those information workers engaged in primary industries within government, e.g., printing, legal services.

[b] Machlup adjusts GNP to include imputations. The 1958 GNP was actually $448,400. Figure used in the Machlup book was $442,200 before adjustments, and $475,600 after adjustments.

[c] State and local education has been accounted in "Education."

Source: Machlup, ibid., Table IX-1, pp. 354-357 and conceptual definitions in the text.

To illustrate the impact of imposing the two restrictions on Machlup's GNP estimates, consider Table 4.1. The table shows Machlup's original estimates in column 1, and the "revised" estimates in column 2. The revisions include two adjustments: (i) all intermediate purchases were removed from the GNP estimate; and (ii) all items that fall outside my concept of a "primary information industry" were removed. The resulting account shows that only 16% of GNP in 1958 was attributable to the primary information sector, as opposed to Machlup's estimate of 29% of GNP. The other 13% of GNP partially encompasses certain secondary information activities.

(3) Use of Value Added

Using the income side of the accounts offers two main advantages. First, it allows the researcher to measure the cost of the secondary information services directly. Second, value added is a more accurate measure of wealth and income originating in the economy since it is insensitive to the cost of goods sold. An item with costly intermediate purchases will "sell" more to final demand since its output price will be correspondingly higher. Two goods with identical wealth-generating attributes could have very different final demand sales, depending on the use of the item. If the good or service is mainly intermediate in nature (such as advertising), it will show a zero final demand but a sizable value added. For example, iron ore sells very little of its output to final demand since most sales are to other firms; yet it generates a considerable amount of wages and profits. By contrast, the jewelry industry sells almost all of its output to final consumers.

The omission of value-added estimates from earlier work undoubtedly reflected the state of data processing facilities available at the time. Without fast computers and, more importantly, very extensive interlocked machine readable data bases, it is doubtful whether a more comprehensive report could have been prepared. In the 15 years since Machlup's research, a wealth of information became available and accessible. Hence, the consolidated accounts presented in this chapter look at the information sector from both the final demand and value-added perspectives. The two measurements of GNP differ considerably, as we shall see below.

A Brief Note on the National Income Accounts

It is outside the scope of this chapter to explain the structure of the National Income Accounts (NIA). However, a brief historical note might be helpful.[3]

The NIA only recently came into being. Before the landmark studies by Kuznets in the 1920's and 1930's, the accounts were sketchy and not systematic.

Quesnay's tableau economique was an early precursor of both the accounts and the input-output matrix. The theoretical groundwork was established by Keynes, who focused on the flows of investment and demand as determinants of income and employment. Keynes took a personal hand at structuring the accounts to suit his analytic purposes. He stressed final consumption (or aggregate demand) as a major determinant of national income. In particular, he stressed government expenditures as a key policy tool.

In the United States, the lead was taken by the National Bureau of Economic Research in the early 1920's. Their early Income and Product Accounts were quite sketchy, and considerably out of data. In 1932, with the impetus of the Great Depression and the pressing need to devise macroeconomic policy, Congress gave the Department of Commerce a mandate to prepare a comprehensive set of national accounts.[4] Simon Kuznets, who had done considerable work with the National Bureau of Economic Research, set the basic fremework in the late 1930's.[5] By 1940, the accounts as we now see them were regularly produced by the National Income Division of the Department of Commerce. The 1945 Budget first contained a set of national accounts. After World War II, the concepts and method of national accounting were adopted by the League of Nations, and diffused rapidly around the world. This work was eventually picked up by the United Nations and the Organization for European Economic Cooperation (OEEC), and an international standard was developed. At present, over 140 countries publish national accounts. The accounts that we now use were only "finalized" in the 1950's. They are still very much in flux, as evidenced by the stream of suggestions and modifications appearing in Commerce's *Survey of Current Business* and in the *Review of Economic Statistics*.

The income and product sides of the accounts are two methods of measuring GNP. The components of income (value added) and product (final demand) are shown in Table 4.2.

TABLE 4.2: GNP CONCEPTS: INCOME AND PRODUCT

Income Side VALUE ADDED	≡	Product Side FINAL DEMAND
Compensation of employees		Personal consumption expenditures
Wages and salaries		Gross private domestic investment
Supplements		Gross domestic private capital formation
Rental income of persons		Net inventory
Corporate profits & inventory valuation adjustments		Net exports of goods and services
Net interest		Gov't purchases of goods & services
Business transfer payments		Federal defense purchases
Indirect business taxes		Federal non-defense purchases
Less: Subsidies less current surplus of government enterprise		State and local purchases
Capital consumption allowances		

In the aggregate, total value added is an identity with total final demand, although for any particular industry, final demand and value added do not (necessarily) balance.

THE CONSOLIDATED ACCOUNTS

In this section we present the consolidated accounts of the primary information sector. The sector has been splintered into the finest detail and aggregated to the most general level. To help the reader, the following is an index to the different levels of aggregation and where they can be found.

TABLE 4.3:

INDEX TO THE PRIMARY INFORMATION SECTOR ACCOUNTS AT DIFFERENT LEVELS OF AGGREGATION

FINAL DEMAND COMPONENTS	
Summary GNP	Tables 4.4, 4.5
Final demand by 2-digit industry	Table 4.10
Detailed final demand by 6-digit I-O industry	Appendix 4, Vol. 8
Detailed final demand by 7-digit SIC code	Appendix 3, Vol. 2
VALUE ADDED COMPONENTS	
Summary National Income	Table 4.6
Gross Product for 11 major sectors	Tables 4.8, 4.9
Gross Product by 2-digit SIC code	Table 4.11
Gross Product by 6-digit I-O industry	Appendix 3, 4, Vols. 2,8

Final Demand

Sales of information goods and services to the four major sectors of final demand accounted for some 21.9% of GNP in 1967. Table 4.4 shows the distribution of the $174.6 billion in final sales. Column 1 of Table 4.4 is identical to that produced by the Bureau of Economic Analysis, except that a statistical adjustment of $924 million was subtracted from total GNP. This was necessary because the recently revised national income benchmark (completed in January, 1976) differs somewhat from the GNP figures published in the 1967 Input-Output tables. The adjustment represents a 0.1% difference, which is well within the 0.5% measurement error associated with the economic censuses.

Table 4.4.--Gross National Product, 1967

[Millions of dollars]

	Total final demand	Information final demand	Information percent of total
Gross national product	**795,388**	**174,585**	**21.9**
Personal consumption expenditures	**490,358**	**83,742**	**17.1**
Durable goods	69,646	5,261	7.6
Nondurable goods	212,593	4,006	1.9
Services	208,119	74,485	35.8
Gross private domestic investment	**120,829**	**21,583**	**17.9**
Fixed investment	110,730	19,958	18.0
Structures	57,430	9,871	17.2
Producers durable	53,300	10,087	18.9
Change in business inventories	10,099	1,625	16.1
Net export of goods and services	**4,937**	**2,942**	**59.6**
Government purchases of goods and services	**180,188**	**66,308**	**36.8**
Federal	90,924	26,796	29.5
State and local	89,264	39,512	44.3
Statistical adjustment	**-924**	....	....

Seventeen cents of every consumer dollar represents purchases of information goods and services. About 8% of all durable goods purchased by households were items such as televisions, radios, hi fi equipment, communication gear, and calculators. Only 2% of all nondurable goods were informational--mostly printed matter--the other 98% including the common household items such as food, clothing, housewares and the like. Services purchased by households were divided 38% to information (e.g., finance, insurance, physicians' counseling, accounting, law) and 62% to noninformation (e.g., auto repair, restaurants, dentists, and hairdressers).

Nearly 18 cents of every dollar invested in the United States was for information machines or buildings. For every dollar spent on computers, telecommunication equipment, printing presses and the like, about $1.28 was spent on office and school buildings to house the information processes that use the machines.

The net trade balance in 1967 was $4.9 billion for the whole economy. The net trade balance in the primary information sector was $2.9 billion--some 59% of total net exports. This surprisingly large percentage is explained in more detail in Appendix 4 (Vol. 8). But it shows that in 1967, information goods and service exports were a significant component of foreign trade in net terms, although they were not nearly as large in gross exports relative to such items as food, chemicals, and heavy equipment.

Federal, State and local governments accounted for some $66.3 billion in purchases of information goods and services. As we shall see in detail in Chapter 8, the government can be split into four parts: (i) the primary information portion of government which includes those governmental services that have direct analogs in the (private) primary information sector; (ii) the secondary information portion of government which has direct analogs to the secondary quasi-industries discussed in Chapter 9--planning, management, etc.; (iii) specialized government information functions which have no direct analog in the private sector--foreign intelligence for example; (iv) noninformation services such as large portions of defense. In the national income accounting scheme, the government's share of GNP includes the purchases of all goods, services, and wages of government workers. The portion allocated to the Federal primary information sector is restricted to the government's purchase of goods and services from the primary information industries plus the wages of workers who are employed in the primary information portion of the Federal government. The Postal Service is not included as a portion of the Federal government since it is treated as a "government industry" in the private sector. The State and local governments' contribution to GNP includes all purchases of goods and services from the primary information sector plus the wages of workers employed in public education. Other than education, which has direct analogs in the primary information sector, all other State and local services were either allocated to the secondary information sector (see Chapter 9) or to noninformation. The largest source of error comes from the lack of easily accessible data on State and local governments. We would prefer to produce a more detailed accounting of State and local outputs, but cannot.

Table 4.5 contains the same information as Table 4.4 transposed to show the goods and services by type of product and purchaser. The table shows that nearly 18% of all durable goods were information machines and equipment. Over half of all durable goods purchased by governments and nearly a third of all durable goods exported (net) by private industry were information machines.

By contrast, only 2.3% of all nondurable goods were informational. Almost the entire amount ($4 billion) was purchased by households. The government purchases of $1.1 billion were mostly for paper, office supplies, and printing.

Information services represented a significant portion of total information final demand (71.5%). Consumers spent over $74 billion on services and governments spent some $48 billion (including the wages of primary information workers). Exports accounted for some $1.8 billion, most of which originated in the sale of royalties and management fees.

Over 21% of all structures were information buildings--offices, schools, libraries, telephone and telegraph facilities. Four out of every ten information structures were purchased by governments; the rest were private office and communication buildings.

Table 4.5.–Gross National Product by Major Type of Product and Purchaser, 1967

	Total final demand (Billion $)	Information final demand (Million $)	Information percent of total
Gross national product	**795.4**	**174,585**	**21.9**
Durable goods	**148.7**	**26,678**	**17.9**
Personal consumption expenditures	69.6	5,261	7.6
Producers durable equipment	53.3	10,087	18.9
Government purchases	16.3	8,848	54.3
Net exports	4.2	1,326	31.6
Change in business inventories	5.3	1,156	21.8
Nondurable goods	**238.5**	**5,392**	**2.3**
Personal consumption expenditures	212.6	4,006	18.8
Government purchases	21.5	1,139	5.3
Net exports	–0.4	–222	–
Change in business inventories	4.8	[a]469	9.8
Services	**326.2**	**124,826**	**38.3**
Personal consumption expenditures	208.2	74,485	35.8
Government purchases	116.9	48,503	41.5
Net exports	1.1	1,838	167.0
Structures	**82.9**	**17,689**	**21.3**
Private structures	57.4	9,871	17.2
Government structures	25.5	7,818	30.7
Statistical adjustment	–1.0	....	....

[a] Includes change in business inventories from service sector.

National Income

Table 4.6 shows the National Income Account for the primary information sector. In 1967, nearly 27% of all income originated with information goods and services. Almost 29 cents of every dollar of *employee compensation* were earned in a primary information industry, whether in the private sector or in the Federal primary information industries. The military was the least information intensive (in wage terms), employing less than one information worker for every three noninformation workers. The civilian government was the most information intensive--almost 43% of all Federal, State and local wages were paid either to the Federal primary information industry workers, to postal service workers, or to education workers.

Proprietors' income, a category of "profit-type" income in the value-added accounts, is divided into business and professional establishments and farms. None of the farm proprietors' income is included in the primary sector, although some information occupations held by farm employees (i.e., pure management) will be accounted as part of the secondary information sector in Chapter 9. About 19% of all business and professional proprietors were informational--mostly unincorporated lawyers, accountants, architects, and small business service firms. The majority of proprietors' income rests with retail establishments, and mostly falls outside the primary information sector.

None of *rental income of persons* appears in the primary information accounts.

Table 4.6 –National Income by Type of Income, 1967

[Millions of dollars]

	Total national income	Information national income	Information percent of total
National income	655,805	176,319	26.9
Compensation of employees	**471,915**	**136,488**	**28.9**
Private	376,514	99,328	26.4
Military	18,842	4,432	23.5
Government civilian	76,559	32,728	42.7
Proprietors' income	**60,974**	**9,187**	**15.1**
Business and professional	48,894	9,187	18.8
Farm	12,080	0	0
Rental income of persons with capital consumption adjustments[a]	**19,376**	**0**	**0**
Corporate profits and inventory valuation adjustment	**79,261**	**33,675**	**42.5**
Profits	77,330	33,675	43.5
Inventory valuation adjustments	1,744	n.a.	....
Capital consumption adjustment	3,675	n.a.	....
Net interest	**24,279**	**–3,031**	–

n.a.–not available.

[a] Capital Consumption Adjustments are adjustments made to depreciation by the Bureau of Economic Analysis, Department of Commerce to reflect current replacement cost.

Over 43% of all corporate profits originated with the primary information industries. All corporations in the United States earned some $79.3 billion in profits in 1967; the primary information industries earned $33.7 billion. This unexpectedly large number was distributed across the information industries as shown in Table 4.7. After removing the government's share of primary sector national income ($37.2 billion), the information industries alone accounted for 21% of national income--but 43% of corporate profits. Each dollar of employee compensation in the information industries generated 34 cents in profits. For the overall economy, the ratio was about 21 cents. This is partly explained by the large profits earned by the telephone and banking industries, which have very high profit to labor ratios.

Corporate profits originating in the information industries are understated by approximately $2.5 billion since we could not develop data on inventory valuation adjustments.

TABLE 4.7: BREAKDOWN OF CORPORATE PROFIT IN THE PRIMARY INFORMATION INDUSTRIES

	($ Millions, 1967)
Information buildings construction	1,200
Non-durable information goods	1,860
Durable information machines and goods	3,762
Communications - telephone, radio, TV	4,392
Trade in information goods	3,232
Banking	6,161
Credit agencies	1,762
Security and commodity brokers	1,013
Insurance carriers	1,024
Insurance agents	1,667
Real estate -- information components	4,177
Misc business information services[a]	190
Misc professional information services[a]	702
Informational components of physicians' offices	4,228
Other information services (e.g. advertising)	1,034
Postal Services	- 946
TOTAL CORPORATE PROFIT: INFORMATION INDUSTRIES	35,458

[a] Most profits in this category were earned as proprietor's income. Total business information service profits were $1,771 million; total professional information service profits were $6,524 million.

Source: BEA Input-Output Worktape.

Value Added

Table 4.8 shows that around 25% of total Gross Product (value added) originated in the primary information industries.

The Gross Product Originating (GPO) table shows the information components that are drawn out of the 11 conventional sectors. The Agriculture and Mining sectors contain no primary information activities. (Their secondary activities--R&D, planning, and coordination--are shown in Chapter 9.)

Nearly 24%, or $8.5 billion, of the Construction sector was value added in building offices, schools, and communications facilities.

Around 15% of the Manufacturing sector value added originated with information goods. The bulk of nondurable manufacturing in the information accounts is printing and publishing. The information durable goods are primarily composed of "electrical machinery," a conventional industry name that includes printing presses, office machines, and computers.

None of the Transportation and the Utility sectors contributed to the primary information accounts.

The entire Communication sector, including telephone, telegraph, radio, and TV broadcasting was allocated to information.

About 12% of the Wholesale and Retail Trade sector margins originated with the sale of information goods. The trade margin represents the difference between the producers' and consumers' prices, or "markup."

Table 4.8 --Gross Product Originating by Industry, 1967

[Millions of dollars]

	Total value added	Information value added	Information percent of total
All industries. total (GNP)	**795,388**	**200,025**	**25.1**
Agriculture, forestry and fisheries	**26,733**	**0**	**0**
Mining	**13,886**	**0**	**0**
Contract construction	**36,102**	**8,527**	**23.6**
Manufacturing	**223,729**	**32,691**	**14.6**
Nondurable goods	**90,595**	**11,762**	**13.0**
Paper and allied products	8,005	1,539	19.2
Printing and publishing	10,718	10,223	95.4
Other	71,872	0	0
Durable goods	**133,134**	**20,929**	**15.7**
Furniture	3,380	528	15.6
Machinery, excluding electric	23,980	3,198	13.3
Electrical machinery	19,959	12,123	60.7
Instruments	5,606	4,309	76.9
Miscellaneous manufacturing	3,305	771	23.3
Other	76,904	0	0
Transportation	**32,040**	**0**	**0**
Communication	**17,632**	**17,609**	(a)
Telephone and telegraph	16,024	16,029	(a)
Radio broadcasting and television	1,608	1,580	(a)
Electric, gas and sanitary services	**18,429**	**0**	**0**
Wholesale and retail trade	**129,863**	**16,053**	**12.4**
Wholesale trade	51,802	8,584	16.6
Retail trade	78,061	7,469	9.6
Finance, insurance, and real estate	**108,840**	**41,425**	**38.1**
Banking	11,843	11,731	(a)
Credit agencies, holding and other investment companies	-437	-790	....
Security and commonity brokers	3,582	2,779	77.6
Insurance carriers	7,822	8,826	(a)
Insurance agents, brokers and service	3,344	3,485	(4)
Real estate	82,686	15,394	18.6
Services	**86,992**	**43,021**	**49.4**
Personal and miscellaneous repair services	9,751	853	8.7
Miscellaneous business services	11,919	10,703	89.8
Motion pictures	1,690	1,525	(a)
Amusement and recreation services	3,607	485	13.4
Medical and other health services	21,392	5,754	26.9
Miscellaneous professional services	12,738	12,183	95.6
Educational services	5,446	5,170	(a)
Nonprofit membership oranizations	7,527	6,348	84.3
Other	12,922	0	0
Government and government enterprises	**95,827**	**40,699**	**42.5**
Federal	40,559	15,771	38.9
General government	35,865	10,232	28.5
Government enterprises	4,694	3,539	75.4

Table 4.8 – Gross Product Originating by Industry, 1967 – Continued

	Total value added	Information value added	Information percent of total
State and local	55,268	26,928	48.7
General government	49,222	26,928	54.7
Government enterprise	6,046	0	0
Rest of the world	**4,510**	0	0
Statistical adjustment	**802**	....	....

([a]) Discrepancy between National Income Accounts and Input-Output Worktape–100% of industry allocated to information.

Over 38% of the Finance, Insurance and Real Estate sector was allocated to the primary information accounts. Note that only 19% of the real estate value added originated in brokerage, office rentals, and trade in intellectual property.

Nearly half of the conventional service sector was allocated to information. Most of the miscellaneous business services (89.8%) and professional services (95.6%) were purely informational in nature. By contrast, very little of the repair (8.7%) and amusement (13.4%) industries were involved with information goods or services.

The government's GPO originated in three ways: (i) about $3.5 billion from the Postal Service as a primary information enterprise; (ii) $10.2 billion from the employee compensation paid to information workers employed in primary Federal Government information services; and (iii) $26.9 billion in the employee compensation paid to State and local government education workers.

In all, over $200 billion of a total gross product of $795.4 billion originated in information goods and services. The information "activity," discussed in Chapter 3, is a composite of industries that presently reside in seven major sectors of the economy. Table 4.9 shows the same $200 billion displayed by major sector, and broken down into components. Nearly 30% of total employee compensation was earned in the information industries. A detailed breakdown of this number is given in Chapter 7, on the "Information Occupations." Nearly 18% of all capital consumption allowances were taken on information machines and structures in the primary information industries. Around 16% of indirect business taxes, such as excise taxes, was paid to the government on information goods and services (such as movies) sales. Nearly 27% of total profit-type income was earned in the information industries. This figure includes profits earned by corporations (about $33.7 billion) and retained earnings of proprietors ($9.2 billion). The public sector accounted for $40.1 billion, or some 5% of total gross product. The private sector primary information--the portion that is produced for market exchange--accounted for 20% of value added. That is, one fifth of GNP originated in the private market production,

Table 4.9 –Gross Product by Industry, Total and by Components, 1967

[Millions of dollars]

	Total value added	Information value added	Information percent of total
All industries, total (GNP)	795,388	200,025	25.1
Employee compensation	467,240	136,488	29.2
Net interest	24,416	–3,031	–
Capital consumption allowances	68,895	12,151	17.6
Indirect business taxes	73,524	11,555	15.7
Profit-type income	160,508	42,862	26.7
Private sector	[b]708.8	159,326	22.5
Employee compensation	382.2	94,895	24.8
Net interest	24.4	–3,031	–
Capital consumption allowance	68.9	12,151	17.6
Indirect business taxes	73.5	11,503	15.7
Profit-type income	160.5	43,808	27.3
Agriculture, forestry, and fisheries	26,733	0	0
Employee compensation	3,706	0	0
Net interest	2,368	0	0
Capital consumption allowances	5,670	0	0
Indirect business taxes	2,199	0	0
Profit-type income	12,790	0	0
Mining	13,886	0	0
Employee compensation	5,188	0	0
Net interest	n.a.	0	0
Capital consumption allowances	3,265	0	0
Indirect business taxes	1,134	0	0
Profit-type income	4,228	0	0
Contract construction	36,102	8,527	23.6
Employee compensation	26,600	6,972	26.2
Net interest	264	29	11.0
Capital consumption allowances	1,961	225	11.5
Indirect business taxes	917	100	10.9
Profit-type income	6,360	1,201	18.9
Manufacturing	223,729	32,691	14.6
Employee compensation	152,265	24,449	16.1
Net interest	2,321	268	11.5
Capital consumption allowances	17,354	1,942	11.2
Indirect business taxes	15,473	410	2.6
Profit-type income	36,316	5,622	15.5
Nondurable goods	90,595	11,762	13.0
Employee compensation	55,793	8,872	15.9
Net interest	967	54	5.6
Capital consumption allowances	7,396	800	10.8
Indirect business taxes	11,393	176	1.5
Profit-type income	15,046	1,860	12.4
Durable goods	133,134	20,929	15.7
Employee compensation	96,472	15,577	16.1
Net interest	1,354	214	15.8
Capital consumption allowances	9,958	1,142	11.5
Indirect business taxes	4,080	234	5.7
Profit-type income	21,270	3,762	17.7

Table 4.9–Gross Product by Industry, Total and by Components, 1967–Con.

[Millions of dollars]

	Total value added	Information value added	Information percent of total
Transportation	32,040	0	0
Employee compensation	21,809	0	0
Net interest	940	0	0
Capital consumption allowances	4,745	0	0
Indirect business taxes	2,332	0	0
Profit-type income	2,214	0	0
Communication	17,632	17,609	(a)
Employee compensation	7,703	7,703	100.0
Net interest	691	691	100.0
Capital consumption allowances	2,462	2,462	100.0
Indirect business taxes	2,375	2,361	(a)
Profit-type income	4,401	4,392	(a)
Telephone, telegraph, and related services	16,024	16,029	(a)
Employee compensation	6,641	6,641	100.0
Net interest	645	645	100.0
Capital consumption allowances	2,279	2,279	100.0
Indirect business taxes	2,314	2,330	(a)
Profit-type income	4,145	4,134	(a)
Electric, gas and sanitary services	18,429	0	0
Employee compensation	5,918	0	0
Net interest	1,815	0	0
Capital consumption allowances	3,693	0	0
Indirect business taxes	2,118	0	0
Profit-type income	4,885	0	0
Wholesale and retail trade	129,863	16,053	12.4
Employee compensation	73,986	8,765	11.8
Net interest	1,039	143	13.8
Capital consumption allowances	6,680	880	13.2
Indirect business taxes	24,622	3,033	12.3
Profit-type income	23,536	3,232	13.7
Wholesale trade	51,802	8,584	16.6
Employee compensation	28,138	4,533	16.1
Net interest	420	79	18.8
Capital consumption allowances	2,268	469	20.7
Indirect business taxes	12,960	1,980	15.3
Profit-type income	8,016	1,523	19.0
Retail trade	78,061	7,469	9.6
Employee compensation	45,848	4,232	9.2
Net interest	619	64	10.3
Capital consumption allowances	4,412	411	9.3
Indirect business taxes	11,662	1,053	9.0
Profit-type income	15,520	1,709	11.0
Finance, insurance and real estate	108,840	41,425	38.1
Employee compensation	22,364	20,197	90.3
Net interest	12,734	-4,319	–
Capital consumption allowances	16,754	4,721	28.2
Indirect business taxes	20,177	5,022	24.9
Profit-type income	36,811	15,804	42.9

Table 4.9 – Gross Product by Industry, Total and by Components, 1967–Con.

[Millions of dollars]

	Total value added	Information value added	Information percent of total
Services	86,992	43,021	49.4
Employee compensation	53,871	26,809	49.8
Net income	1,309	157	12.0
Capital consumption allowances	6,311	1,921	30.4
Indirect business taxes	2,102	577	27.5
profit-type income	23,399	13,557	57.9
Government and government enterprises	95,827	40,699	42.3
Employee compensation	93,790	41,593	44.3
Net interest	0	0	0
Capital consumption allowances	0	0	0
Indirect business taxes	75	52	69.3
Profit-type income	1,962	–946	–
General government	85,087	37,160	43.7
Employee compensation	85,087	37,160	43.7
Net interest	0	0	–
Capital consumption allowances	0	0	–
Indirect business taxes	0	0	–
Profit-type income	0	0	–
Rest of the world	4,510	0	–
Employee compensation	40	0	–
Net interest	864	0	–
Capital consumption allowances	0	0	–
Indirect business taxes	0	0	–
Profit-type income	3,606	0	–

([a]) Discrepancy between National Income Accounts and Input-Output Worktape–100% of industry allocated to information.
([b])Private sector reported in billions of dollars.

distribution and exchange of information goods and services. The table contains a statistical discrepancy between the "Total" column and the "Information" column since the two relevant data bases were estimated by the Bureau of Economic Analysis (BEA) at different occasions. The "Total" column was estimated and published as part of the national income accounts, and the other figure was derived from the input-output work tape. The discrepancy is between .001% and 0.1%. For example, the total communications GPO was given in the national income accounts as $17,632 million and in input-output as $17,609 million. Both numbers are shown, although we have used the input-output as the basis of computing percentages. Hence, the numbers shown here are consistent with the detail shown in Appendix 3 (Vol. 2).

Detail Backup

Tables 4.10 and 4.11 contain somewhat more detailed breakdowns of the final demand and value-added components at the 2-digit SIC level.

For even finer breakdowns at the 6-digit I-O level the reader is referred to Appendix 4 (Vol. 8).

TABLE 4.10: COMPONENTS OF FINAL DEMAND AT THE 2-DIGIT SIC LEVEL

($ Millions, 1967)

	PERSONAL CONSUMPTION EXPENDITURES	GROSS CAPITAL FORMATION	NET INVENTORY CHANGE	NET EXPORTS	FEDERAL PURCHASES OF GOODS & SVCS	STATE&LOCAL PURCHASES OF GOODS & SVCS	TOTAL INFORMATION FINAL DEMAND
Total Primary Information Inds	83,752.0	19,957.8	1,625.4	2,942.6	26,795.6	39,512.2	174,585.6
Total Private Sector	82,666.8	19,957.8	1,625.4	2,944.3	16,292.4	12,356.2	135,842.9
Total Public Sector	1,085.2	0	0	- 1.7	10,503.2	27,156.0	38,742.6
CONTRACT CONSTRUCTION	0	5,430.9	0	2.2	407.5	7,410.3	13,250.9
MANUFACTURING	9,266.6	10,086.5	1,559.6	1,102.2	8,216.6	1,770.1	32,001.6
Nondurable goods	4,005.7	0	403.5	- 222.2	208.0	930.7	5,325.9
Paper & allied products	50.3	0	106.7	- 451.3	35.1	85.0	- 174.2
Printing & publishing	3,955.4	0	296.8	229.3	172.9	845.7	5,500.1
Durable goods	5,260.9	10,086.5	1,156.1	1,324.2	8,008.6	839.4	26,675.7
Furniture	0	628.5	26.3	- 6.6	46.2	283.4	977.8
Machinery, exc electrical	112.1	3,964.6	190.2	620.0	550.1	166.0	5,603.0
Electrical Machinery	3,816.6	3,584.1	759.0	189.2	6,468.5	144.9	14,962.3
Misc manufacturing	203.8	241.4	17.7	20.5	2.5	16.6	502.3
Instruments	1,128.6	1,667.9	162.9	501.1	941.3	228.5	4,603.3
COMMUNICATION	7,836.8	1,095.7	0	6.6	543.5	471.3	9,953.9
Telephone & telegraph	7,836.8	1,095.7	0	7.1	543.5	464.1	9,947.2
Radio & TV	0	0	0	- .5	0	7.2	6.7
TRADE	13,582.1	1,244.7	122.6	690.2	245.3	122.6	16,007.5
Wholesale trade	6,376.9	981.1	122.6	690.2	245.3	122.6	16,007.5
Retail trade	7,205.2	263.6	0	0	0	0	0
FINANCE, INSURANCE, REAL ESTATE	24,880.7	2,100.0	0	168.6	275.0	855.4	28,279.7
Banking	8,384.3	0	0	69.9	34.6	0	8,488.8
Credit agencies	2,350.0	0	0	0	- 5.8	0	2,344.2
Security & commodity brokers	2,149.1	0	0	0	0	107.9	2,257.0
Insurance carriers	11,675.6	0	0	- 80.0	16.9	261.7	11,873.4
Insurance agents	0	0	0	0	0	0	0
Real estate	321.7	2,100.0	0	179.5	229.3	485.8	3,316.3
SERVICES	27,100.6	0	- 56.8	974.5	6,604.5	1,726.5	36,349.3
TOTAL GOVERNMENT	1,085.2	0	0	- 1.7	10,503.2	27,156.0	38,742.7
Primary wages - Federal	0	0	0	0	10,231.9	0	10,231.9
Education wages - State & local	0	0	0	0	0	26,928.0	26,928.0
Postal services	1,085.2	0	0	- 1.7	271.3	228.0	1,582.8

TABLE 4.11: COMPONENTS OF VALUE ADDED AT THE 2-DIGIT SIC LEVEL

($ Millions, 1967)

	EMPLOYEE COMPENSATION	NET INTEREST	CAPITAL CONSUMPTION ALLOWANCES	INDIRECT BUSINESS TAXES	PROFIT-TYPE INCOME	TOTAL INFORMATION VALUE ADDED
Total Primary Information Industries	136,488.0	- 3,031.0	12,151.0	11,555.0	42,862.0	200,025.0
Total Private Sector	94,895,0	- 3,031.0	12,151.0	11,503.0	43,808.0	159,326.0
Total Public Sector	41,593.0	0	0	52.0	- 946.0	40,699.0
CONTRACT CONSTRUCTION	6,972.0	29.0	225.0	100.0	1,201.0	8,527.0
MANUFACTURING	24,449.0	268.4	1,941.6	410.6	5,621.8	32,691.4
Nondurable goods	8,872.3	53.8	799.8	176.3	1,860.0	11,762.2
Paper & allied products	1,146.1	34.7	246.6	41.3	70.0	1,538.7
Printing & publishing	7,726.2	19.1	553.2	135.0	1,790.0	10,223.5
Durable goods	15,576.7	214.6	1,141.8	234.3	3,761.8	20,929.2
Furniture	403.3	2.5	23.4	9.5	88.9	527.6
Machinery, exc electrical	1,885.9	37.0	176.1	33.9	1,065.4	3,198.3
Electrical Machinery	9,717.7	139.0	604.6	136.4	1,525.4	12,123.7
Misc manufacturing	636.9	4.0	28.2	8.4	93.7	771.2
Instruments	2,932.9	32.1	309.5	46.1	988.4	4,309.0
COMMUNICATION	7,703.0	691.0	2,462.0	2,361.0	4,391.9	17,609.0
Telephone & telegraph	6,641.0	645.0	2,279.0	2,330.0	4,134.0	16,029.0
Radio & TV	1,062.0	46.0	183.0	31.0	257.9	1,579.9
TRADE	8,765.4	142.9	880.4	3,032.5	3,231.9	16,053.1
Wholesale trade	4,533.4	78.8	469.3	1,979.5	1,523.3	8,584.3
Retail trade	4,232.0	64.1	411.1	1,053.0	1,708.6	7,468.8
FINANCE, INSURANCE, REAL ESTATE	20,197.2	-4,319.3	4,721.4	5,021.7	15,803.9	41,424.9
Banking	5,875.0	-1,268.0	589.0	373.6	6,160.9	11,703.5
Credit agencies	2,581.0	-5,565.2	359.1	73.2	1,762.2	-789.7
Security & commodity brokers	1,540.6	- 146.3	31.3	340.9	1,012.9	2,779.4
Insurance carriers	7,237.8	- 872.8	329.0	1,108.6	1,023.6	8,826.2
Insurance agents	1,729.0	- 48.0	115.0	21.4	1,667.1	3,484.5
Real estate	1,233.8	3,581.0	3,298.0	3,104.0	4,177.2	15,394.0
SERVICES	26,809.0	157.2	1,920.5	577.2	13,557.0	43,021.0
TOTAL GOVERNMENT	41,593.0	0	0	52.0	- 946.0	40,699.0
Primary wages - Federal	10,231.9	0	0	0	0	10,232.0
Education wages - State & local	26,928.0	0	0	0	0	26,928.0
Postal services	4,433.4	0	0	51.6	- 946.0	3,439.0

FOOTNOTES

[1] The concept and definitions of the National Income and Product Accounts changed several times since the 1930's. The accounts in Chapter 4 follow the format shown in the *Survey of Current Business*, January 1976, Vol. 56, No. 1 (Parts 1 and 2). See also, Department of Commerce, *The National Income and Product Accounts of the United States, 1929-1965*. For a methodological compendium, see Department of Commerce, *Readings in Concepts and Methods of National Income Statistics*.

[2] See E. Denison, "Welfare Measurement and the GNP," *Survey of Current Business*, January 1971.

[3] Methodological issues in national income accounting were resolved by the following: John Kendrick, *Economic Accounts and Their Uses*, McGraw-Hill, 1972; Richard and Nancy Ruggles, *National Income Accounts and Income Analysis*, McGraw-Hill, New York, 1956; Richard and Nancy Ruggles, *The Design of Economic Accounts*, National Bureau of Economic Research, 1970; Simon Kuznets, *National Income and Its Composition*, National Bureau of Economic Research, 1941; and National Bureau of Economic Research, *A Critique of the United States Income and Product Accounts*, Princeton University Press, Princeton, New Jersey, 1958.

[4] *National Income, 1929-1932*, 73rd Congress, 2nd Session, Senate Document #124, 1934.

[5] See National Bureau of Economic Research's *Income in the United States: Its Amount and Distribution, 1909-1919*, Vol. I and II, Harcourt, Brace and Company, New York, 1921. Due to methodological differences between Kuznets and the Department of Commerce, there exist two separate time series on GNP. They were finally reconciled in the 1940's.

CHAPTER FIVE

SECULAR TRENDS OF THE PRIMARY INFORMATION SECTOR

Once an organism is born or a phenomenon uncovered, there is an almost irresistible urge to measure its growth. In this chapter, we trace the growth of the primary information sector from its infancy before the Great Depression to its present size. This chapter also forms the basis for estimating the secondary information sector national income, reported in chapter 9.

Growth of the Primary Information Sector

Machlup estimated the average growth rate of the knowledge industries' revenues at 10.6% per year between 1947 and 1958.[1] During that period, a number of spectacular developments were occurring in several information industries. Between 1949 and 1958, TV broadcasting revenues increased by 2,930%, or 46% per year, starting from a zero base in 1947. Between 1954 and 1958, the computer industry grew at the rate of 104% annually; TV broadcasting grew 77% per year; office machine parts increased at 30% per year; Federal education programs grew at 25% per year. Machlup's estimates are included in summary form as Table 5.1.

Our own estimates are based not on growth of revenues, which can often be large where the output price of a commodity or a service is high, but national income, which more closely measures the relative value of the product in relation to the production of wealth in the economy. National income is a proxy for GNP. For example, in 1967, national income was 82% of GNP, with the balance made up by capital consumption allowances (17.5%) and indirect business taxes (0.5%). We would have preferred to produce a time series based on Gross Product Originating, but the data simply do not exist in sufficient detail and consistency over the 46 years covered by the time series.

National income originating in the detailed primary information sector industries, as explained in Appendix 3 (Vol. 2), was measured for the period 1929-1974. The detailed prorations (at the 7-digit SIC level in many cases, or as deep as the census would permit in others) were aggregated up to the 2-digit SIC level to correspond to the National Income and Products Accounts classification scheme. Sources, methods, and procedures are outlined in Appendix 5 (Vol. 8). The reader should be warned that the conventional industry names used in the following tables hide the informational content of the good or service that the industry provides. For a reminder concerning the detailed composition of these industries, refer to Appendix 3 (Vol. 2).

TABLE 5.1:

KNOWLEDGE PRODUCTION: RATES OF INCREASE FOR ALL BRANCHES, 1954-1958 AND 1947-1958, OR SIMILAR PERIODS

BRANCH OF KNOWLEDGE PRODUCTION		% INCREASE PER YEAR		% INCREASE PER YEAR
Education				
Elementary & secondary schools	1954-1956	9.5	1948-1958	12.0
Colleges & universities	1954-1958	13.2	1948-1958	7.5
Federal funds, n.e.c.	1954-1958	24.9		
Public libraries	1954-1958	8.2		
Research & development				
Basic research	1954-1958	17.9	1949-1958	16.4
Applied R&D	1954-1958	18.8		
Printing & publishing				
Books & pamphlets	1954-1958	10.7	1947-1958	7.4
Periodicals	1954-1958	2.9	1947-1958	4.1
Newspapers	1954-1958	4.5	1947-1958	6.3
Stationery and other office supplies	1954-1958	7.5	1947-1958	6.2
Commercial printing and lithography	1954-1958	1.9	1947-1958	4.9
Photography & phonography				
Photography	1954-1958	7.1	1948-1954	12.2
Phonography	1954-1958	19.6	1947-1958	6.1
Stage, podium & screen				
Theatres & concerts	1954-1958	8.0	1947-1958	4.7
Spectator sports	1954-1958	3.2	1947-1958	1.3
Motion pictures	1954-1958	-0.8	1947-1958	-2.8
Radio & television				
Radio stations revenue	1954-1958	3.8	1947-1958	3.4
Television stations revenue	1954-1958	14.8	1947-1958	77.2
Radio & TV sets & repairs	1954-1958	-3.7	1947-1958	5.5
Radio & TV stations invest.	1954-1957	10.7	1947-1957	18.3
Other advertising	1954-1958	5.9	1947-1958	8.7
Telecommunications media				
Telephone	1954-1958	9.3	1947-1958	10.9
Telegraph	1954-1958	3.9	1947-1958	2.4
Postal service	1954-1958	4.7	1947-1958	5.6
Information machines				
Printing trades machinery	1954-1958	5.7	1947-1958	4.1
Musical instruments	1954-1958	9.1	1947-1958	6.1
Telephone & telegraph equip.	1954-1958	10.6	1947-1958	6.2
Signaling devices			1947-1954	5.2
Measuring & controlling instruments	1954-1958	7.9	1947-1958	13.5
Typewriters	1953-1958	5.6	1947-1958	4.0
Electronic computers	1954-1958	104.4		
Other office machines	1953-1958	3.8		
Office machine parts	1953-1958	30.2		
Professional services				
Legal	1953-1958	8.4	1947-1958	8.3
Engineering & architectural	1953-1958	8.2	1947-1958	9.4
Accounting & auditing	1953-1958	11.8	1949-1957	12.2
Medical	1953-1958	8.0	1947-1958	6.8
Joint with financial services				
Check-deposit banking				
Joint with financial services				
Securities brokers, etc.	1954-1958	9.4	1947-1958	15.5
Insurance agents	1954-1958	6.0	1947-1958	8.9
Wholesale agents			1948-1954	6.6
Miscellaneous business svcs	1954-1958	10.6		
Government				
Federal	1953-1958	1.3		
State and local	1954-1958	8.0		
Total knowledge production		8.8		10.6

Source: Machlup, *ibid.*, pp. 368-374.

Table 5.2 shows a condensed version of the time series for selected years between 1929-1974. The years were chosen because they coincide with the economic censuses (Manufacturing, Business, and Construction) in most cases, whereas some of the other years were estimated by interpolation and hence are not as reliable. The complete time series is shown in Appendix 5 (Vol. 8).

In 1929, around 18% of national income (or $15,841 million) originated in the provision of information goods and services, mostly in the private sector of the economy ($13.6 billion). During the Depression, national income was sliced in half (from $86.8 billion to $40.3 billion), and the information industries were also victims of massive cutbacks, dropping from $15.8 billion in 1929 to $9.2 billion in 1933. However, their share of national income actually increased from 18% to 23%--3% representing a relative increase in the private sector, and 2% in the public sector. Certain information industries such as communications and insurance brokers resisted the Depression more successfully than others.

As economic recovery continued, we see that the information industries dropped to 19% of national income by 1939. With U.S. entry into World War II, the share of national income dropped even further (to a low of 15%), and by 1948--the base year for Machlup's estimates--began its upward climb from a level of 17% of national income.

The next 26 years showed monotonic growth, climbing slowly but steadily from 17% in 1948 to 27% by 1967, reaching 28% in 1972 and 29% in 1974. These developments exclude the "secondary information sector" growth discussed in Chapters 9 and 10. The time series is strictly on the primary information industries.

Table 5.2.–National Income by Industry, 1929-1972 (Selected Years)

[Millions of dollars, current]

Industry	1929			1933			1939		
	Total national income	Information national income	Information percent of total	Total national income	Information national income	Information percent of total	Total national income	Information national income	Information percent of total
All industries, total	86,795	15,841	18.25	40,312	9,189	22.79	72,564	14,085	19.41
Agriculture	8,473	–	–	3,872	–	–	6,026	–	–
Mining	2,101	–	–	628	–	–	1,633	–	–
Construction	3,835	568	14.80	788	120	15.20	2,342	372	15.90
Manufacturing	21,945	2,190	9.98	7,705	982	12.74	18,094	1,854	10.24
Nondurable goods	10,642	1,526	14.34	4,944	793	16.04	9,093	1,253	13.77
Paper and allied products	558	113	20.20	290	66	22.80	555	140	25.22
Printing, publishing and allied industries	1,588	1,413	89.00	809	727	89.85	1,221	1,113	91.14
Nondurable manufacturing, n.e.c.	8,496	–	–	3,845	–	–	7,317	–	–
Durable goods	11,303	664	5.87	2,761	189	6.84	9,001	601	6.67
Furniture	675	71	10.50	182	20	11.25	507	60	11.88
Machinery, except electrical	1,891	166	8.80	426	38	8.90	1,496	135	9.03
Electrical machinery	1,047	293	28.00	279	82	29.25	858	268	31.24
Instruments[a]	–	–	–	–	–	–	–	–	–
Miscellaneous manufacturing	607	134	22.00	202	49	24.20	522	138	26.35
Durable manufacturing, n.e.c.	7,083	–	–	1,672	–	–	5,618	–	–
Transportation	6,605	–	–	3,038	–	–	4,643	–	–
Communication	1,128	1,128	100.00	702	702	100.00	1,075	1,075	100.00
Electric, gas, and sanitary services	1,638	–	–	1,287	–	–	1,766	–	–
Wholesale and retail trade	13,511	1,754	12.98	5,625	817	14.52	12,604	1,572	12.47
Finance, insurance, and real estate	12,813	4,918	38.38	5,877	2,095	35.64	7,991	2,997	37.50
Banking	2,018	2,018	100.00	692	692	100.00	880	880	100.00
Credit agencies	–	–	100.00	–	–	100.00	–	–	100.00
Security and commodity brokers	726	563	77.60	191	148	77.60	204	158	77.60
Insurance agents	849	849	100.00	552	552	100.00	904	904	100.00
Insurance agents	421	421	100.00	289	289	100.00	390	390	100.00
Real estate	8,630	898	10.40	4,164	425	10.20	5,450	501	9.20
Holding companies	169	169	100.00	−11	−11	100.00	163	163	100.00
Services	8,843	3,066	34.66	5,141	2,180	42.39	7,554	2,879	38.10
Personal services	1,287	50	3.90	707	28	3.90	1,053	37	3.50
Miscellaneous business services	608	231	38.00	358	136	37.90	676	191	28.30
Miscellaneous repair services	315	14	4.60	191	9	4.60	261	28	10.70
Motion pictures	440	440	100.00	210	210	100.00	434	434	100.00
Amusements and recreation	379	42	11.00	154	15	9.50	288	21	7.20
Medical and other health services	1,536	479	31.20	948	339	35.80	1,381	435	31.50
Legal services	689	689	100.00	561	561	100.00	692	692	100.00
Educational services	402	402	100.00	363	363	100.00	415	415	100.00
Nonprofit membership organizations	640	512	80.00	527	422	80.00	556	445	80.00
Miscellaneous professional services	206	206	100.00	98	98	100.00	181	181	100.00
Services, n.e.c.	2,341	–	–	1,024	–	–	1,617	–	–
Rest of the world	810	–	–	323	–	–	313	–	–
Private sector, subtotal	81,702	13,623	16.67	34,986	6,895	19.70	64,041	10,749	16.78
Government and government enterprises	5,093	2,218	43.54	5,326	2,293	43.06	8,523	3,336	39.14
Federal	1,460	697	47.76	1,649	720	43.63	4,133	1,435	34.72
General government	879	252	28.70	1,164	348	29.90	3,414	884	25.90
Government enterprises	581	445	76.60	485	372	76.60	719	551	76.60
State and local	3,633	1,521	41.85	3,677	1,574	42.80	4,390	1,901	43.30
General government	3,456	1,521	44.00	3,531	1,574	44.57	4,185	1,901	45.42
Government enterprises	177	–	–	146	–	–	205	–	–

[a] Redefined as an industry in 1948.

Table 5.2.–National Income by Industry, 1929-1972 (Selected Years)–Con.

[Millions of dollars current]

Industry	1948			1954			1958		
	Total national income	Information national income	Information percent of total	Total national income	Information national income	Information percent of total	Total national income	Information national income	Information percent of total
All industries, total	225,860	37,982	16.8	305,328	62,947	20.6	370,807	84,902	22.9
Agriculture	22,271	–	–	17,132	–	–	18,610	–	–
Mining	5,447	–	–	5,271	–	–	5,730	–	–
Construction	10,696	1,701	15.9	15,690	2,934	18.7	18,891	3,646	19.3
Manufacturing	68,795	6,894	10.0	94,708	10,834	11.4	107,900	13,331	12.4
Nondurable goods	32,911	3,684	11.2	39,719	5,181	13.0	45,771	6,274	13.7
Paper and allied products	2,353	560	23.8	3,410	732	21.5	4,084	829	20.3
Printing, publishing and allied industries	3,357	3,124	93.1	4,715	4,449	94.4	5,731	5,444	95.0
Nondurable manufacturing, n.e.c.	27,201	–	–	31,594	–	–	35,956	–	–
Durable goods	35,884	3,210	8.9	54,989	5,653	10.3	62,129	7,057	11.4
Furniture	1,193	131	11.0	1,558	177	11.3	1,804	207	11.5
Machinery, except electrical	6,329	590	9.3	9,140	869	9.5	9,894	950	9.6
Electrical machinery	4,031	1,531	38.0	6,688	2,840	42.5	8,400	3,755	44.7
Instruments	1,038	820	79.0	2,021	1,603	79.3	2,463	1,958	79.5
Miscellaneous manufacturing	1,606	138	8.6	1,388	165	8.7	2,127	187	8.8
Durable manufacturing, n.e.c.	21,687	–	–	33,694	–	–	37,441	–	–
Transportation	12,809	–	–	14,639	–	–	16,545	–	–
Communication	2,820	2,820	100.0	5,065	5,065	100.0	7,014	7,014	100.0
Electric, gas, and sanitary services	3,176	–	–	5,928	–	–	7,450	–	–
Wholesale and retail trade	39,877	4,042	10.1	48,271	5,701	11.8	58,369	7,243	12.4
Finance, insurance, and real estate	19,083	6,973	36.5	33,053	13,074	39.6	42,852	17,608	41.1
Banking	2,541	2,541	100.0	4,465	4,465	100.0	6,017	6,017	100.0
Credit agencies	-157	-157	100.0	-341	-341	100.0	-596	-596	100.0
Security and commodity brokers	292	227	77.6	682	529	77.6	1,192	925	77.6
Insurance carriers	1,919	1,919	100.0	3,297	3,297	100.0	3,979	3,979	100.0
Insurance agents	677	677	100.0	1,330	1,330	100.0	1,740	1,740	100.0
Real estate	13,765	1,721	12.5	23,435	3,609	15.4	30,238	5,261	17.4
Holding companies	46	46	100.0	185	185	100.0	282	282	100.0
Services	19,976	7,864	39.4	27,687	11,790	42.6	38,339	17,174	44.8
Personal services	2,842	136	4.8	3,505	203	5.8	4,241	242	5.7
Miscellaneous business services	1,436	1,028	71.6	2,663	1,875	70.4	4,096	3,191	77.9
Miscellaneous repair services	704	80	11.4	826	155	18.8	987	214	21.7
Motion pictures	903	903	100.0	955	955	100.0	827	827	100.0
Amusements and recreation	831	63	7.6	1,040	103	9.9	1,377	175	12.7
Medical and other health services	3,921	1,223	31.2	5,871	1,391	23.7	9,068	2,294	25.3
Legal services	1,176	1,176	100.0	1,758	1,758	100.0	2,232	2,232	100.0
Educational services	944	944	100.0	1,370	1,370	100.0	1,999	1,999	100.0
Nonprofit membership organizations	1,462	1,170	80.0	2,441	1,953	80.0	3,337	2,670	80.0
Miscellaneous professional services	1,140	1,140	100.0	2,026	2,026	100.0	3,331	3,331	100.0
Services, n.e.c.	4,617	–	–	5,232	–	–	6,844	–	–
Rest of the world	1,163	–	–	1,809	–	–	2,243	–	–
Private sector, subtotal	206,113	30,294	14.7	269,253	49,398	18.3	323,943	66,017	20.4
Government and government enterprises	19,747	7,688	38.9	36,075	13,550	37.6	46,664	18,885	40.3
Federal	10,586	3,707	35.0	20,190	6,558	32.5	23,792	8,527	35.8
General government	8,910	2,424	27.2	17,780	4,712	26.5	20,545	6,040	29.4
Government enterprises	1,676	1,284	76.6	2,410	1,846	76.6	3,247	2,487	76.6
State and local	9,161	3,981	43.5	15,885	6,992	44.0	23,072	10,357	44.9
General government	8,521	3,981	46.7	14,698	6,992	47.6	21,578	10,357	48.0
Government enterprises	640	–	–	1,187	–	–	1,494	–	–

Table 5.2.–National Income by Industry, 1929-1972 (Selected Years)–Con.

[Millions of dollars current]

Industry	1963			1967			1972		
	Total national income	Information national income	Information percent of total	Total national income	Information national income	Information percent of total	Total national income	Information national income	Information percent of total
All industries, total	484,026	118,899	24.56	655,617	173,935	26.53	956,771	266,293	27.83
Agriculture	18,463	–	–	20,694	–	–	30,649	–	–
Mining	5,776	–	–	6,385	–	–	8,700	–	–
Construction	24,707	4,472	18.10	34,105	6,412	18.80	52,277	9,044	17.30
Manufacturing	143,189	19,182	13.39	193,159	29,446	15.24	251,811	37,612	14.93
Nondurable goods	57,224	8,084	14.12	74,526	11,005	14.76	97,943	14,782	15.09
Paper and allied products	5,264	1,037	19.70	6,820	1,528	22.40	9,421	1,575	19.90
Printing, publishing and allied industries	7,398	7,047	95.25	9,934	9,477	95.40	13,530	12,908	95.40
Nondurable manufacturing, n.e.c.	44,562	–	–	57,772	–	–	74,992	–	–
Durable goods	85,965	11,098	12.91	118,633	18,442	15.54	153,868	22,830	14.83
Furniture	2,365	284	12.00	3,189	462	14.50	4,526	577	12.75
Machinery, except electrical	14,099	1,650	11.70	21,794	3,029	13.90	27,294	4,040	14.80
Electrical machinery	12,309	6,179	50.20	18,538	10,567	57.00	23,353	12,809	54.85
Instruments	3,447	2,744	79.60	5,103	4,082	80.00	6,457	4,991	77.30
Miscellaneous manufacturing	2,576	242	9.40	3,307	301	9.10	4,586	413	9.00
Durable manufacturing, n.e.c.	51,169	–	–	66,702	–	–	87,652	–	–
Transportation	19,943	–	–	25,203	–	–	36,453	–	–
Communication	9,889	9,889	100.00	13,385	13,385	100.00	20,311	20,311	100.00
Electric, gas, and sanitary services	10,333	–	–	12,659	–	–	17,589	–	–
Wholesale and retail trade	72,961	9,332	12.79	97,643	13,054	13.36	144,606	19,761	13.66
Finance, insurance, and real estate	56,101	22,949	40.90	74,477	31,920	42.85	112,493	49,504	44.00
Banking	7,976	7,976	100.00	10,726	10,726	100.00	17,074	17,074	100.00
Credit agencies	–1,560	–1,560	100.00	–2,155	–2,155	100.00	–3,381	–3,381	100.00
Security and commodity brokers	1,403	1,089	77.60	3,131	2,430	77.60	4,348	3,374	77.60
Insurance carriers	5,226	5,226	100.00	7,454	7,454	100.00	12,507	12,507	100.00
Insurance agents	2,444	2,444	100.00	3,295	3,295	100.00	5,217	5,217	100.00
Real estate	40,292	7,454	18.50	51,420	9,564	18.60	76,373	14,358	18.80
Holding companies	320	320	100.00	606	606	100.00	355	355	100.00
Services	54,239	25,234	46.52	79,096	38,415	48.56	122,344	58,870	48.11
Personal services	5,255	284	5.40	6,924	436	6.30	7,471	411	5.50
Miscellaneous business services	6,648	4,860	73.10	10,655	8,652	81.20	16,551	11,933	72.10
Miscellaneous repair services	1,304	271	20.80	1,744	321	18.40	2,557	476	18.60
Motion pictures	916	916	100.00	1,349	1,349	100.00	1,576	1,576	100.00
Amusements and recreation	1,964	145	7.40	2,574	335	13.00	3,745	337	9.00
Medical and other health services	13,150	3,195	24.30	20,172	4,700	23.30	36,586	7,756	21.20
Legal services	3,528	3,528	100.00	5,003	5,003	100.00	8,398	8,398	100.00
Educational services	3,321	3,321	100.00	5,156	5,156	100.00	8,010	8,010	100.00
Nonprofit membership organizations	5,157	4,126	80.00	6,499	5,199	80.00	10,646	8,517	80.00
Miscellaneous professional services	4,588	4,588	100.00	7,264	7,264	100.00	11,456	11,456	100.00
Services, n.e.c.	8,408	–	–	11,756	–	–	15,348	–	–
Rest of the world	3,678	–	–	4,561	–	–	7,049	–	–
Private sector, subtotal	419,279	91,057	21.71	561,367	132,632	23.62	804,282	195,101	24.25
Government and government enterprises	64,747	27,842	43.00	94,250	41,303	43.82	152,489	71,192	46.68
Federal	29,565	10,920	36.93	41,493	14,904	35.91	59,724	24,073	40.30
General government	25,164	7,549	30.00	35,612	10,399	29.20	50,060	16,670	33.30
Government enterprises	4,401	3,371	76.60	5,881	4,505	76.60	9,664	7,403	76.60
State and local	35,182	16,921	48.09	52,757	26,399	50.04	92,765	47,119	50.79
General government	32,857	16,921	51.50	49,530	26,399	53.30	87,312	47,119	53.96
Government enterprises	2,325	–	–	3,227	–	–	5,453	–	–

Short Period Growth Rates

Table 5.3 shows the simple and compound growth rates during the period 1929-1972. The information industries grew at a simple growth rate of 39% between 1929-1972, or a compound rate of 6.6%. The period 1939-1954 showed a very rapid growth, especially buoyed by large investments in information structures (e.g., office and education buildings) and information machines (e.g., communications and computing equipment). The most recent period (1963-1972) showed a compound growth rate of 9% per year, doubling every eight years.

Table 5.3 shows the losses incurred during the Depression, and the increase of public sector primary information activities. Whereas all sectors of the economy declined between 1929 and 1933, communications (-9.4%) and the other information services (-7.2%) declined the least--compared to a 20% drop for manufacturing and construction. The private information sector as a whole dropped 10.5% annually between 1929 and 1933. The public sector increased, however, at an average rate of 0.8%, slowly picking up a variety of primary information tasks and workers from the private economy. The administration of the numerous recovery programs instituted during these years partly accounted for this increase. (Note that the government information sector excludes all noninformation workers such as road and dam builders and forestry workers.)

With the Depression over, information industries in the (conventional) manufacturing and construction sectors showed a remarkable comeback, posting simple growth rates of 40% and 30% annually between the years 1939-1948. Information machines such as televisions, radios, computers, and business machines grew very rapidly, with growth rates of 38% and 52% during 1933-1938 and 1939-1948.

The boom began to slow by 1954, with the information economy expanding at a "modest" 8% during each of the next four years. Since then, the primary information sector has just slightly outpaced the overall economy, increasing 4% annually between 1963 and 1967, and jumping by 7% between 1967 and 1972.

TABLE 5.3: GROWTH RATES FOR THE PRIMARY INFORMATION SECTOR NATIONAL INCOME, 1929-1972

SELECTED INFORMATION COMPONENTS	SIMPLE												COMPOUND			
	1929-1972	1929-1948	1948-1963	1963-1972	1929-1933	1933-1939	1939-1948	1948-1954	1954-1958	1958-1963	1963-1967	1967-1972	1929-1972	1929-1948	1948-1963	1963-1972
Agriculture	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mining	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Construction	39.1	10.5	10.9	12.4	-19.7	35.1	39.6	12.1	6.1	4.5	10.8	8.2	6.6	5.9	6.2	7.4
Manufacturing	40.7	11.3	11.9	11.0	-13.8	14.8	30.2	9.5	5.8	8.8	13.4	5.5	6.7	6.2	6.6	6.8
Nondurable goods	21.5	7.4	8.0	9.2	-12.0	9.7	21.6	6.8	5.3	5.8	9.0	6.9	5.3	4.7	5.0	6.0
Paper & allied products	39.3	20.9	5.7	9.4	-10.3	18.6	33.3	5.1	3.3	5.0	11.8	4.5	6.6	8.8	3.9	6.1
Printing,publish&allied inds	20.1	6.4	8.4	9.2	-12.1	8.8	20.1	7.1	5.6	5.9	8.6	7.2	5.1	4.3	5.2	6.0
Nondurable manufacturing,nec	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Durable goods	85.0	20.2	16.4	12.3	-17.9	36.4	48.2	12.7	6.2	11.5	16.5	4.8	8.3	8.6	8.1	7.4
Furniture	17.3	4.5	7.8	10.9	-17.8	32.4	13.1	5.8	4.4	7.4	15.7	5.0	4.8	3.3	4.9	6.8
Machinery, exc electrical	64.1	13.4	12.0	18.3	-19.3	42.7	37.4	7.9	23.0	14.7	20.9	6.7	7.7	6.9	6.6	9.6
Electrical machinery	10.7	22.2	20.2	12.1	-18.0	38.1	52.3	14.3	8.1	12.9	17.8	4.2	8.8	9.1	9.1	7.3
Instruments	---	---	15.6	9.6	---	---	---	15.9	5.5	8.0	12.2	4.5	---	---	7.8	6.2
Misc manufacturing	5.0	0.2	5.0	7.1	-15.8	30.2	0.0	3.2	3.4	5.9	6.1	7.4	2.6	0.2	3.6	4.9
Durable manufacturing,nec	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Transportation	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Communication	4.6	7.9	16.7	12.7	- 9.4	8.9	18.0	13.3	9.6	8.2	8.8	10.3	6.8	4.9	8.2	7.6
Electric,gas&sanitary services	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Wholesale & retail trade	25.8	6.9	8.7	12.4	-13.4	15.4	17.5	6.8	6.8	5.8	10.0	10.3	5.7	4.5	5.4	7.5
Finance,insurance&real estate	33.8	2.2	15.3	22.5	-14.4	7.2	14.7	14.6	8.7	6.1	9.8	11.0	6.2	1.9	7.7	10.9
Banking	24.1	1.4	14.3	18.2	-16.4	4.5	21.0	12.6	8.7	6.5	8.6	11.8	5.5	1.2	7.4	9.6
Credit agencies	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Security & commodity brokers	93.9	-3.1	25.4	194.3	-18.4	1.1	4.8	22.3	18.7	3.5	30.8	7.8	8.5	-4.7	10.3	29.6
Insurance carriers	33.3	6.6	11.5	14.5	- 8.7	10.6	12.5	12.0	5.2	6.3	10.7	13.6	6.2	4.4	6.5	8.3
Insurance agents	31.2	3.2	17.4	14.5	- 7.8	5.8	8.2	16.1	7.7	8.1	8.7	11.7	6.1	2.5	8.4	8.3
Real estate	39.0	4.8	22.2	11.2	-13.2	3.0	27.0	18.3	11.4	8.3	7.1	10.0	6.6	3.5	9.6	6.9
Holding companies	12.5	-3.8	39.7	-31.3	-26.6	---	-8.0	50.4	13.1	2.7	22.3	-8.3	---	-6.6	12.9	---
Services	51.9	8.2	14.7	17.8	- 7.2	5.3	19.2	8.3	11.4	9.4	13.1	10.6	7.2	5.1	7.6	9.5
Personal services	18.0	9.0	7.2	5.6	-11.3	5.6	30.0	8.2	4.7	3.5	13.4	-1.2	4.9	5.4	4.7	4.1
Miscellaneous business services	15.2	18.2	24.8	20.9	-10.3	6.8	48.6	13.7	17.5	10.5	19.5	7.6	9.7	8.2	10.2	10.5
Miscellaneous repair services	8.9	23.9	15.9	10.8	- 9.8	36.3	20.8	15.6	9.5	5.3	4.6	9.6	8.4	9.4	7.9	6.8
Motion pictures	7.7	5.5	0.1	10.5	-13.1	17.8	12.0	1.0	-3.4	2.2	11.8	3.4	3.3	3.9	0.1	6.6
Amusements & recreation	10.6	2.7	8.7	17.7	-16.2	7.0	22.7	10.5	17.5	-3.4	32.6	0.1	5.5	2.2	5.3	9.4
Medical & health services	43.0	8.2	10.7	18.6	- 7.3	4.7	20.1	2.3	16.2	7.9	11.8	13.0	6.8	5.1	6.2	9.7
Legal services	32.8	3.7	13.3	18.9	- 4.6	3.9	7.8	8.2	6.7	11.6	10.5	13.6	6.2	2.9	7.1	9.8
Education services	53.5	7.1	16.8	18.5	- 2.4	2.4	14.2	7.5	11.5	13.2	13.8	11.1	7.3	4.6	8.2	9.7
Nonprofit membership org.	4.0	6.8	16.8	12.5	- 4.4	0.9	18.1	11.2	9.2	10.9	6.5	12.8	6.6	4.4	8.2	7.5
Miscellaneous professional svcs	15.6	23.9	20.2	20.0	-13.1	14.1	58.9	13.0	16.1	7.5	14.6	11.5	9.7	9.4	9.1	10.2
Services, nec	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Government and government ent.	82.6	13.0	17.5	18.5	0.8	7.6	14.5	12.7	9.8	9.5	12.1	14.5	8.2	6.8	8.4	9.7
Federal	84.0	22.7	13.0	13.4	0.8	16.6	17.6	12.8	7.5	5.6	9.1	12.3	8.3	9.2	7.0	7.9
General government	15.7	45.3	14.1	12.6	9.5	25.7	19.3	15.7	7.0	5.0	9.4	12.1	9.7	12.6	7.4	7.5
Government enterprises	42.8	9.9	10.8	15.2	- 4.1	8.0	14.8	7.3	8.7	7.1	8.4	12.9	6.8	5.7	6.2	8.5
State and local	81.9	8.5	12.7	21.8	0.9	3.5	12.2	12.6	12.0	12.7	14.0	15.7	8.2	5.2	9.5	10.7
General government	81.9	8.5	21.7	21.8	0.9	3.5	12.2	12.6	12.0	12.7	14.0	15.7	8.2	5.2	9.5	10.7
Government enterprises	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Private Sector	45.1	6.4	13.4	16.2	-10.5	8.9	18.9	11.0	8.7	8.0	11.6	10.6	6.9	10.5	8.4	7.6
All industries, TOTAL	39.1	7.4	14.2	16.7	-12.3	9.3	20.2	10.5	8.4	7.6	4.3	7.1	6.6	4.7	7.4	8.4

FOOTNOTES

[1] Machlup, *The Production and Distribution of Knowledge in the United States*, Princeton University Press, Princeton, New Jersey, 1962, pp. 366-374.

CHAPTER SIX

THE PRIMARY INPUT-OUTPUT MATRIX

> Planning is the organized application of systematic reasoning to the solution of specific practical problems.... Far from being incompatible or mutually exclusive, the automatic mechanism of free competition and the principle of deliberate action guided by rational decision both play their different but equally important parts in the operation of our economic system.... The issue that confronts top [political and business] management is not how to choose between unrestricted competition and all-pervasive planning, but rather how to choose an effective combination of the two.
>
> Wassily Leontief, Input-Output Economics
> Oxford University Press, New York, 1966, p. 1

Input-Output economics was developed as a planning tool in the 1940's. Leontief's first practical application was during World War II when he investigated the dislocations that might occur as the United States shifted from a wartime to a peacetime economy. Since the first small national tables were produced, starting with the 1929 economy, input-output (I-O) matrices have grown in size, accuracy, and usefulness. They are now employed as a planning tool in over 40 nations.

The first general equilibrium models produced by Walras, and later by others were purely theoretical models of an ideal economy, and not empirically soluble. The profound contribution of I-O analysis was that a general (numerical) solution for a wide class of problems could be generated, with immediate policy planning relevance.

An I-O transactions table shows the flow of goods and services throughout the entire economy. Industries are both producers and consumers of goods and services, and the intermediate (inter-industry) flows form the heart of the I-O matrix. The I-O transactions table also shows the flow to the final demand sectors and the value added generated by each industry.

Figure 6.1 shows a simplified overview of an I-O transactions table. The information sector, appearing as one of the eight major sectors, is composed of the industries described in Chapters 3 and 4, and in Appendix 3 (Vol. 2). To read an I-O table, the following simple guide should be used:

> The output of each industry is distributed across the row to other firms (intermediate demand) and to final demand consumers.

FIGURE 6.1: INPUT-OUTPUT TRANSACTIONS TABLE SHOWING MAJOR SECTORS

		CONSUMER'S INTERMEDIATE DEMAND								FINAL DEMAND[a]			
		Info	Agriculture	Mining	Construction	Manufacturing	Trade	Transportation	Services	Persons	Investors	Foreigners	Government
PRODUCERS	Information									Personal consumption expenditures	Gross private domestic investment	Net exports of goods and services	Government purchases of goods and services
	Agriculture												
	Mining												
	Construction, net												
	Manufacturing, net												
	Trade, net												
	Transportation												
	Services, net												
VALUE ADDED[b]	Employees		Employee compensation							GROSS NATIONAL PRODUCT			
	Owners of Business and Capital		Profit-type income and capital consumption allowances										
	Government		Indirect business taxes										

[a] Corresponds to the National Income & Product Accounts (See Tables 4.1 & 4.2).

[b] Corresponds to the National Income & Product Accounts (See Tables 4.4 & 4.5).

The purchases, or inputs of each firm are composed down the column of each industry in the intermediate sectors, including an input of value added.

Relation of Input-Output to the National Income Accounts

The margins of an I-O table are identical to the consolidated National Income and Product Accounts discussed in Chapter 4. Total GNP, which is the sum of all final demand purchases (equal to all components of value added) is reported in the 1967 I-O table as $795,388 million. The first NIA figures for 1967, published in 1969, showed GNP as $793,927 million and contained a small statistical error. The recently revised 1967 benchmark tables (published in January, 1976) again contained different figures, as summarized in Table 6.1. We shall proceed with the published I-O control totals (line b) rather than make adjustments to reconcile the matrix with the 1976 estimates. Hence there will be a $924 million discrepancy between the I-O matrix and the consolidated accounts of Chapter 4.

TABLE 6.1: ALTERNATE ESTIMATES OF THE 1967 GROSS NATIONAL PRODUCT

	(Millions)
(a) National Income & Product Accounts (July 1973)	$793,927
(b) Input-Output Tables (February 1974)	795,388
(c) National Income & Product Accounts Benchmark Revision (January 1976)	796,312

Source: See Survey of Current Business for date given in parenthesis.

Once the margins are "locked" into place, the I-O table is completely consistent with the national accounts.

The technology matrix, or "A" matrix, is simply a table of direct input requirements. Each industry's inputs (column) are scaled by the total input, including value added, so that the resulting ratios sum to 1.00. These "technical coefficients" show each industry's composition of inputs from all other industries necessary to produce $1.00 of gross output. A change in technology can be precisely specified by changing the coefficients in the A matrix; or for the capital structure, by changing the coefficients of an expanded capital flow matrix that resides in the final demand tables.

The *inverse* of the technology matrix, $(I-A)^{-1}$ shows the total (direct and indirect) requirements generated by a $1.00 increase in final demand for the outputs of a particular industry.

A Simple Illustration

The easiest way to show the use of the matrix is to solve a sample problem: "What is the total effect on the economy resulting from a $1 million computer sale?" Table 6.2 shows the inputs of the computer industry as they appear in the transactions table. All other sectors have been temporarily ignored.

TABLE 6.2: INPUT REQUIREMENTS OF THE COMPUTER INDUSTRY (IO #51) FOR 1967

IO#	PRODUCING INDUSTRY	PURCHASES ($ MILLION)	DIRECT REQUIREMENTS	TOTAL REQUIREMENTS
51	Computers	881	.13182	1.15435
53	Electric apparatus	145	.02169	.03465
55	Electric wiring equipment	159	.02375	.03057
57	Electronic components	720	.10779	.15171
69	Wholesale & retail trade	246	.03683	.07067
71	Real estate & rental	255	.03821	.06604
73	Business services	149	.02086	.05314
81	Business travel	157	.02350	.03601
	All other industries	1,052	.18397	n/a
	Intermediate inputs	3,932	.58842	---
	Value added	2,750	.41158	---
	Total inputs	6,682	1.00000	---

Source: See *Survey of Current Business*, "The Input-Output Structure of the U.S. Economy: 1967", February 1974, Vol. 54, No. 2.

The computer industry purchased $3,932 million from all industries in 1967, including a sizable purchase of $881 million from other computer firms, as shown in column 1. The industry generated $2,750 million in value added, for a total input of $6,682 million. When column 1 is divided through by the total input figure, we find the direct requirements per $1.00 output in column 2. To satisfy a $1.00 increase in final demand, the computer industry generates 13 cents in sales internally; it also buys 2 cents worth of electrical apparatus, 2 cents of wiring, 11 cents in electronic components, 2 cents worth of business travel, entertainment and gifts, and so on. However, each *supplier* of the computer industry now experiences an increase in *its* total requirements (since its intermediate demands went up *by* the amount in Column 2), and must therefore purchase supplies from other firms in the economy. For example, let us take a closer look at the electronic components industry #57. Table 6.3 shows the sum of the inputs to Industry #57.

TABLE 6.3:

FIRST ROUND INDIRECT EFFECT OF A $1 MILLION SALE OF COMPUTERS: PURCHASES OF THE ELECTRONIC COMPONENTS INDUSTRY OF $107,790

IO#	PRODUCING INDUSTRY	(1)	(2)
27	Chemicals and selected chemical products	.01343	1,448
32	Rubber and plastic products	.01966	2,119
38	Primary nonferrous manufacturers	.03473	3,744
51	Office and computing machines	.00784	845
57	Electronic components	.14011	15,103
	.	.	.
	.	.	.
	.	.	.
	Value added	.44716	48,199

When the computer industry sells a $1 million machine to final demand, the electronics component industry receives a $107,790 increase for its output. (This is determined simply by multiplying the direct coefficient of industry #57 in Table 6.2 by $1 million.) To satisfy the increase, it must purchase the amounts shown in column 2 of Table 6.3 from other industries. The industry purchases $1,448 worth of chemicals, $2,119 worth of plastics, $3,744 in sheet metal, about $845 from the computer industry which initiated the transaction in the first place, and $15,103 internally. The industry's value added increases by $48,199--including employee compensation, profits, and indirect business taxes. This is the first-round indirect effect of a $1 million computer sale to final demand.

However, we are not yet finished. Each industry in Table 6.3 must now purchase some inputs from its suppliers to satisfy the new intermediate demand shown in Column 2.

To continue the example, let us just look at one of the impacted industries--primary nonferrous manufacturers--and trace that industry's new purchases. The second-round requirements generated by the nonferrous metal industry is shown in capsule form in Table 6.4.

TABLE 6.4:

SECOND ROUND INDIRECT EFFECT OF A $1 MILLION COMPUTER SALE: PURCHASES OF THE NON-FERROUS METAL INDUSTRY OF $3,744

IO#	PRODUCING INDUSTRY	(1)	(2)
6	Non-ferrous metal ores mining	.05042	189
80	Gross imports	.09808	367
83	Scrap, used and secondhand good	.02651	99
	Value added	.27381	1,025

The nonferrous metal industry receives a first-round increase in output of \$3,744 on the sale of the \$1 million computer, as shown in Table 6.3. To satisfy this new requirement, it purchases \$189 from the nonferrous ores mining industry, \$367 from imports, about \$99 from the recycling industries, and generates a total value added (wages and profits) of \$1,025.

Each of the other industries listed in Table 6.4 also generates a second round effect. The increase in the mining industry's requirement generates a third-order indirect effect on *its* suppliers--and so on.

This ripple effect through the economy is simultaneously and completely captured for all industries by the *inverse of the technology matrix*. (More accurately, the subtraction of the technology from the identity matrix, I-A.) The inverse gives a solution equivalent to about 14 iterations of the direct effects (A) matrix. After the 15th iteration, the numbers begin to vanish into the fractions of dollars. Mathematically, the inverse is equivalent to the Gauss-Seidel method of estimating a power expansion.

Returning for a moment to the computer industry, let us see what the direct and indirect effects of a \$1 million purchase are on selected industries. The total effects are displayed in Table 6.5.

TABLE 6.5 : TOTAL EFFECTS OF A \$1 MILLION COMPUTER SALE

IO#	PRODUCING INDUSTRY	DIRECT EFFECT	INDIRECT EFFECT	TOTAL EFFECT
51	Office computing	\$131,820	\$1,022,530	\$1,154,350
53	Electric apparatus	21,690	12,960	34,650
55	Electric wiring	23,750	6,820	30,570
57	Electronic components	107,790	43,920	151,710
69	Trade	36,830	33,840	70,670
71	Real estate & rental	38,210	27,830	66,040
73	Business services	20,860	32,280	53,140
81	Imports	23,500	12,510	36,010
	All other industries	183,970	413,890	597,860
	TOTAL INTERMEDIATE REQUIREMENTS	588,420	1,606,580	2,195,000
	VALUE ADDED	411,580	---	---
	TOTAL	\$1,000,000		

In column 1, we see the direct requirements on the computer industry resulting from the $1 million sale to final demand--$588,420 went to purchase goods and services from other (intermediate) industries, and $411,580 went for employee compensation, profits, depreciation, and business taxes.[1] In column 2 we see the effects of 14 rounds of purchases touched off by the requirements of the computer industry. Most of the purchases stimulated the computer industry itself; other industries enjoyed about $600,000 of new sales as a result of the $1 million computer sale. In all, the total effect on industry output was about $2.2 million, as shown in column 3.

Input-Output Notation

A compact way of describing the solution shown in the illustration is by using matrix notation. We construct a simple three-industry economy, and show why the inverse captures the entire (direct plus indirect) effect of a change in final demand.

The output of an industry is the sum of all final and intermediate demand purchases. This relationship is shown in Equation 1

(1) $x_i = (x_{i1} + x_{i2} + x_{i3}) + D_i$ where,

x_i -- the total output of industry i

x_{ij} -- the flow of industry i's goods to industry j, $\Sigma x_{ij} = x_i$

D_i -- the total final demand for industry i's output

As we have seen, each industry buys a portion of its total inputs from all other industries. This empirical reality is represented as follows:

(2) $x_{ij} = (a_{ij})(x_j)$. where,

a_{ij} -- is the fraction of the industry j inputs that are purchased from industry i.

Or, a_{ij} can be seen as the technical coefficient showing exactly how much of good i is needed to produce on unit of good j, as follows:

(3) $$a_{ij} = \frac{x_{ij}}{x_j}$$

The technical coefficients, a_{ij}, are produced by scaling through the columns of the transactions matrix, as shown in Equation 3. The three-industry economy of Equation 1 can be written as follows:

$$
\begin{array}{lccccccccc}
(4) & x_1 & = & a_{11}x_1 & + & a_{12}x_2 & + & a_{13}x_3 & + & D_1 \\
 & x_2 & = & a_{21}x_1 & + & a_{22}x_2 & + & a_{23}x_3 & + & D_2 \\
 & x_3 & = & a_{31}x_1 & + & a_{32}x_2 & + & a_{33}x_3 & + & D_3 \\
 & \text{Total Output} & = & \multicolumn{5}{c}{\text{Intermediate Demand}} & + & \text{Final Demand}
\end{array}
$$

If we rearrange terms to isolate D on one side of the equation, and collect all terms in x on the other side,

$$
\begin{array}{lccccccc}
(5) & (1 - a_{11})\,(x_1) & - & (a_{12})\,(x_2) & - & (a_{13})\,(x_3) & = & D_1 \\
 & -(a_{21})\,(x_1) & + & (1 - a_{22})\,(x_2) & - & (a_{23})\,(x_3) & = & D_2 \\
 & -(a_{31})\,(x_1) & - & (a_{32})\,(x_2) & + & (1 - a_{33})\,(x_3) & = & D_3
\end{array}
$$

The system of equations in 5 is essentially complete, and will yield a complete solution to the experiment we have been considering. To clean up the algebra, Equations 4 and 5 can be written in matrix notation as follows:

$$(4') \quad X = A X + D$$

$$(5') \quad X - A X = D$$

$$(5'') \quad (I - A) X = D$$

where,

I -- is the identity matrix, $\begin{pmatrix} 100 \\ 010 \\ 001 \end{pmatrix}$

A -- is the matrix of technical coefficients, a_{ij}

X -- is the vector of industry outputs

The last step is to isolate X, the vector of total requirements, on one side of the equation. Equation 5 is premultiplied on both sides by $(I - A)^{-1}$, yielding

$$(6) \quad (I - A)^{-1} (I - A) \ X = (I - A)^{-1} D$$

$$(7) \quad X = (I - A)^{-1} D$$

The first two terms in Equation 6 cancel each other out, leaving Equation 7 in the classical estimating form. Equation 7 shows that the total outputs of all industries can be derived by multiplying a final demand bill of goods (D) through a matrix of coefficients, $(I - A)^{-1}$, that can be produced from empirical observations. Once $(I - A)^{-1}$ is known, general equilibrium solutions (supply = demand for the whole economy) can be found.

The Information Sector and Input-Output Analysis

Our purposes in building an I-O matrix are twofold: first, it offers a complete description of the transactions between the information industries and the rest of the economy, and hence is a significant improvement over the simple National Income Accounts structure; second, it opens up a rich variety of policy questions that are amenable to I-O analysis yielding solutions involving the information sector. The structure within the information sector can be investigated in detail, as can the structure between the information sector and the rest of the economy. I shall briefly introduce five classic types of problems and suggest how they can shed light on the behavior of the information sector.

Class I: Changes in Final Demand

The most common application of I-O analysis is to trace through the effects on the economy given a change in final demand. Equation 7 above is in exactly the right form to conduct all the experiments suggested in this class of problems.

Final demand is composed of the following ten detailed sectors:

1. Personal consumption expenditures
2. Gross private fixed capital formation
3. Net inventory change
4. Net exports
5. Federal defense expenditures
6. Federal nondefense expenditures
7. State and local purchases for education
8. State and local purchases for health, welfare, and sanitation
9. State and local purchases for safety
10. Other state and local government purchases

Underlying data are available to splinter these final demand sectors even more finely. For example, the Federal defense sector can be splintered into purchases by the Department of Defense, the National Aeronautics and Space Administration, and the Energy Research and Development Administration separately. Or, the Federal nondefense sector can be divided into discrete government procurement programs, such as education programs, safety and health programs, pollution abatement programs, and income redistribution programs. The Gross Capital Formation component, which usually appears only as a column vector, can now be split into a rectangular capital flow matrix. The matrix shows the detailed capital structure of the 82 I-O industries.

The classic input-output experiment is to change a component of final demand and trace the effects of the experimental change on industry output. For example, a government procurement program's effect on industries (both direct and indirect) can be estimated. The effects of changes in foreign exchange rates or tariff rules can be traced through net export's effect on output. Tax legislation dealing with research and development expense or depreciation schedules can be "gamed" through the matrix. Technological substitution favoring communications and computer systems can be modeled. We will consider two experiments in this tradition later in the chapter.

Class II: Change in Technology

Another application of I-O methodology is tracing through the effects of technological change on the economy. Whereas Class I problems made use of the $(I - A)^{-1}$ matrix, this class of problems involves operations on the technology (A) matrix and on the capital flow matrix in final demand.

Each column in the A matrix represents a unique technology, a "recipe" of goods and services necessary to make the finished product. Changes in technology can be interpreted as changes in the recipe--a little less of this and more of that. The researcher can, by modifying the coefficients in the A matrix, create new economies that reflect changed technology.

Systematic changes in technology, such as substitution of communication for travel (if one believes the hypothesis), can be experimentally "gamed" into the A matrix. A change in the ratio of labor earnings to capital can also be modeled, since value added (including employee compensation) is one of the input coefficients. And, as the user can control the matrix at the 507 order, extremely fine changes in technology can be represented.

Armed with a detailed A matrix and a capital flow matrix, many alternative technological futures can be represented. For example, the use of telecommunication (on current account) and computers (on capital account) can be increased experimentally, and the impacts traced on all industries' output and employment patterns.

Class III: Change in Relative Prices

The output of any given industry at producers' prices reflects the current price level. An inflationary or deflationary change in prices would necessarily alter the output price of the industry's goods or services. Ignoring for a moment any price substitution effects, a 30% price rise in money terms (i.e., intermediate and final outputs) would show up as an inflated total output. Since the theoretical framework for input-output work is that it reflects a physical flow of goods, builders of operational matrices take great care to deflate each industry's output into real dollars, so that a change in prices does not erroneously indicate a change in real output.

However, that procedure can be reversed. An inflationary bulge can be easily modeled as a nominal rise in the industry's output. A final demand vector, when multiplied through the inverse, will yield new (higher) outputs for all industries in the economy that are either directly or indirectly linked with the inflated sector. By subtracting the control economy (preinflation) from the experimental economy (with one or more inflated industries), the analyst obtains an exact measure of the inflationary "ripple" through the economy.

After an inflated transactions matrix has been built and inverted, the following question can be answered: "Is the primary information sector inflationary or not with respect to a rise in the price of energy resources?" A hypothetical price rise in a variety of fuel sources (petroleum, natural gas, oil) can be posited; and the inflationary impact on the information and noninformation industries can be gauged.

Class IV: Labor Requirements

Since output-to-labor ratios are well known for each industry, any net rise in output induced by an experiment can immediately be translated into new labor requirements. By translating the new labor requirement through the known detailed occupational composition of each industry, a very specific job impact statement can be produced.

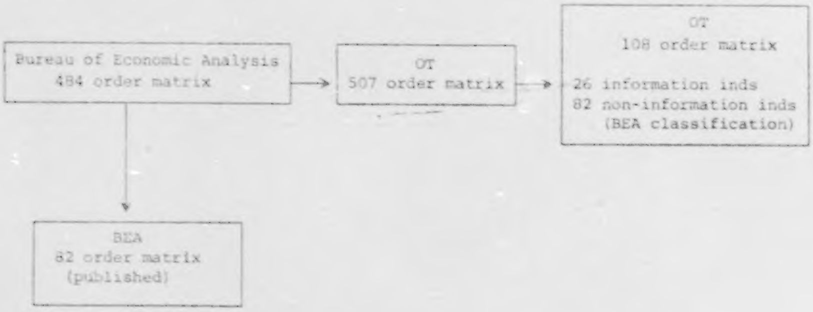
Class V: Capital Requirements

Even though output-to-capital ratios are known, this is a much more tricky proposition than computing labor requirements. There is considerable difficulty in determining the true definition of one unit of capital.[2] Hence, the ratio itself is ambiguous. Once some satisfactory measure of capital requirements is derived, the next hurdle is to measure idle or excess capacity carried by the industry. There are severe problems in arriving at a common measure of "capital utilization," and here, too, the analysis is somewhat subjective. If these problems can be solved, new capital requirements can be generated and decomposed into hundreds of detailed types of capital goods required by each industry as a result of an experiment.

TWO INPUT-OUTPUT EXPERIMENTS

In this section I shall present the results of two experiments using the input-output matrix. The experiments are "first looks" at the general relationship between the primary information sector and the overall economy.

Appendix 6 (Vols. 3, 4, 5) contains a full description of the transactions matrix, the direct requirements (technology) matrix, and its inverse. The sources, methods, and procedures are outlined in detail in Appendix 6 (Vols. 3, 4, 5). No discussion will follow here, except to state that we are using a 108 order matrix developed from the following data:


Bureau of Economic Analysis
484 order matrix
OT
507 order matrix
OT
108 order matrix
26 information inds
82 non-information inds
(BEA classification)
BEA
82 order matrix
(published)

The OT 108-order matrix is the current version of the primary information sector matrix. Any order matrix from 2 by 2 to 507 by 507 can also be produced. The detailed industry reports contained in this chapter are at the 108 order.

Experiment I - A Compensated Defense Cut

In 1961, Leontief published a now classic application of input-output analysis. I chose to replicate his experiment to illustrate how the primary information matrix can be used.

The "arms race" and its economic impact on the United States entered the public consciousness during the late 1950's. President Eisenhower, whose loyalty to both the military and private industry was resolute, ended his Presidency in 1960 with a surprise warning that the "military-industrial complex" was a creature to be restrained. Casual evidence persuaded most people that corporate interests were so finely enmeshed with military expansion that arms buildups began to carry an imperative independent of stated public policy. Could the U.S., as a nation, afford *not* to engage in stockpiling of increasingly expensive and sophisticated war machines? This question was tackled by Leontief and Hoffenberg, and brought to the public attention in an article published in 1961.[3] The authors concluded that the economic effects of disarmament may not be as severe as the most fearful suspected. In equilibrium, output and labor lost as a result of cuts in defense spending would be reallocated to other final demand sectors, and have a positive impact on other industries in the economy. The ordnance industry would suffer (in 1958) a 19.2% drop in employment given an $8 billion (or 20%) defense cut; the aircraft industry would experience a 17.9% unemployment rate; and the ships and boats industry would lose 11% of its employees. But other industries would gain somewhat, especially those selling to personal consumption and to the nondefense portions of government. The *net impact* on 1958 employment of a 20% compensated defense cut would be a mild 0.22% increase in unemployment for the total economy. But the business sector, excluding civilian government employment, would suffer considerably. Business employment would decrease by 6.85%--a severe recession for the business community. The authors conclude by stating that their model is only qualitative in nature, and that further refinement is necessary.

The experiment is relevant to the information industries for an obvious reason. The entire thrust of modern warfare has been to substitute information technology for manpower. Avionics, advanced communications networks, satellites and management information systems are key components of the U.S. defense establishment. Hence, a drastic change in defense procurement policies can affect profits and employment in the information industries.

I have reproduced the Leontief experiment for the 1967 economy using somewhat different assumptions. Leontief allocated the money saved by disarmament on a *pro rata* basis to all other final demand categories. The experiment reported in this section returns the defense cut in the form of a direct personal reduction of income taxes in 1967. Hence, the entire amount saved by the defense cutback is "spent" experimentally by households in the form of personal consumption expenditures.

Summary of Experiment I

Table 6.6 shows the gross experimental changes in final demand. Defense spending is cut by 20%, or some $14.3 billion; and personal consumption expenditures are raised by the same amount, leaving final demand constant.

TABLE 6.6:

SUMMARY OF THE EXPERIMENTAL CHANGES IN DEFENSE EXPENDITURES AND PERSONAL CONSUMPTION EXPENDITURES

($ Millions, 1967)

	CONTROL ECONOMY	EXPERIMENTAL ECONOMY	NET CHANGE
Defense purchases	71,333	57,066	-14,267
Personal Consumption Expenditures	490,660	504,927	+14,267
Sub-total Final Demand	561,993	561,993	0

A 20% defense cut and a corresponding rise in personal consumption expenditures leads to a slight increase in output and employment. This conclusion indicates that a seemingly drastic policy--reducing defense spending by 20%--can in fact lead to benign economic ends, if not political ones.

Table 6.7 summarizes the total direct and indirect effects on the economy as a net result of the experimental policy.

A $14,266 million reduction in defense spending, matched by a compensating rise in household expenditures, resulted in a net gain in output of some $8.6 billion and 598,000 jobs. The information industries as a group gained about $1.3 billion in output, and increased their labor requirements by 121,000 jobs; the noninformation industries enjoyed a $7.3 billion gain in output, and "hired" 477,000 workers.

The assumptions regarding personal consumption are purposefully naive. No attempt was made to adjust expenditures for either income or substitution effects; price levels were assumed constant; a unitary price elasticity of demand was used for all goods and services. Likewise, no attempt was made to realistically scale down the defense establishment. It is quite plausible that in the face of a mandated 20% cutback, programs would be selectively trimmed. For example, the Pentagon might decide to substitute capital for labor and invest in cruise missiles, advanced avionics, satellite reconnaissance and the like instead of the foot soldier and the tank driver. The pattern of Department of Defense purchases will probably not be scaled down uniformly, as reflected in this experiment.

TABLE 6.7 :

NET IMPACT ON OUTPUT AND EMPLOYMENT OF A 20 PERCENT COMPENSATED CUT IN DEFENSE SPENDING

	($ Millions, 1967)			(Thousands of Jobs, 1967)		
	OUTPUT			EMPLOYMENT		
	Total	Direct	Indirect	Total	Direct	Indirect
Total	+8,563	5,658	2,905	+598	447	151
Information Inds.	1,268	628	640	121	92	29
Non-Information Inds.	7,295	5,030	2,265	477	355	122

These fine-tuned changes in the spending patterns of final demand can be individually "gamed" through the input-output matrix.

One general statistic that immediately emerges from Table 6.7 is that the information industries are considerably more labor intensive than the noninformation industries. Whereas the ratio of noninformation output to information output was about 6:1, the ratio of noninformation labor to information labor was only 4:1. Or, allocating final demand in the particular manner specified in this experiment caused 1-1/2 times as many jobs to be created per dollar of output gained in the information sector as compared to the noninformation sector.

Output Impact Reports

The output impacts of the experimental cut in defense purchases can be traced through total, direct, and indirect effects. These effects can also be broken down by industry. A rich variety of detail is available in the output reports generated by an I-O experiment, and for any microscopic look at the economy these reports are quite valuable. For our purposes, they have been relegated to Appendix 6 (Vol. 8), where the interested reader can find the following:

Table 17	Final demand components of the experimental economy
Table 18	Total output generated by each final demand component in the experimental economy
Table 19	Direct output generated by each final demand component in the experimental economy
Table 20	Indirect output generated by each final demand component in the experimental economy

Table 21 Net total output generated by each experimental change in final demand

Table 22 Net direct output generated by each experimental change in final demand

Table 23 Net indirect output generated by each experimental change in final demand

Table 6.8 shows the total net impact of a compensated defense cut on the output of selected industries. The biggest gainers are mostly the noninformation industries: retail trade in noninformation goods ($2.8 billion), food ($2.8 billion), housing and noninformation building rentals ($2.1 billion), livestock ($0.8 billion) and other agricultural products ($0.6 billion). Consumers, in short, spent their money on food, housing, and goods. The largest informational gain was the finance and insurance industry: consumers took out loans and purchased insurance with their windfall income.

The biggest noninformation losers were the ordnance (-$1.4 billion) and the aircraft (-$2.2 billion) industries. Since defense procurement is heavily laced with communications equipment, the radio, television, and communication equipment manufacturers lost heavily (-$1.1 billion), as did the electronic components industry (-$0.5 billion).

Labor Impact Reports

The impacts on the labor force can similarly be decomposed into total, direct, and indirect. The technique has been successfully applied to investigate the labor impacts of several Federal programs.[4]

The following output reports are available, but to conserve space they have not been included in the Appendix.

Total employment generated by each final demand component in the experimental economy

Direct employment generated by each final demand component in the experimental economy

Indirect employment generated by each final demand component in the experimental economy

Net total employment generated by each experimental change in final demand

Net direct employment generated by each experimental change in final demand

Net indirect employment generated by each experimental change in final demand

TABLE 6. 8: TOTAL NET OUTPUT IMPACT OF A COMPENSATED DEFENSE SPENDING CUT

($ Millions, 1967)

	SELECTED INDUSTRIES	INFORMATION INDUSTRIES	NON-INFORMATION INDUSTRIES
	Gainers		
69	Wholesale & retail trade, net		2,778
14	Food & kindred products		2,255
71	Real estate & rental, net		2,101
70*	Finance & insurance components	1,065	
1	Livestock & products		759
2	Other agriculture products		607
18	Apparel		580
77	Medical, educ svcs & nonprofit org.		580
68	Electrical, gas, sanitary services		534
77*	Medical, educational, nonprofit	435	
59	Motor vehicles & equipment		407
71*	Real estate: fees,royalties,ofc rent	386	
69*	Trade margins on info goods	383	
16	Fabrics, yarn, & thread mills		265
29	Drugs, cleaning, toilet preps		253
73*	Repair: radio & TV equipment	253	
66*	Telecommunications, exc radio & TV	199	
15	Tobacco manufacturers		196
31	Petroleum refining & related inds		176
79	State & local govt enterprises		135
24	Paper, allied prods exc containers,net		132
8	Crude petroleum & natural gas		119
34	Footwear & other leather prods		113
54	Household appliances		101
	Losers		
60	Aircraft & parts		-2,228
13	Ordnance & accessories		-1,437
56*	Radio, TV, Commn equipment	-1,112	
57*	Electronic components	- 447	
37	Primary iron & steel mfrg.		- 335
38	Primary nonferrous metal mfrg.		- 313
80	Imports		- 296
27	Chemicals & products, net		- 184
11	New construction, net		- 176
62*	Mech measuring & control instr.	- 145	
53	Electrical ind equip & apparatus,net		- 142
65	Transportation & warehousing		- 126
50	Machine shop products		- 114
49	General ind machines & equipment		- 101
	TOTAL NET IMPACT	1,267	7,294

Table 6.9 shows the industries most affected by the experiment. The employment impacts generally follow the pattern established previously in considering output impacts. About 276,000 new jobs are created in the trade sector; another 65,000 new jobs in hospitals and medical clinics become available. Banks and insurance companies hire 61,000 new workers; and schools and physicians' offices hire another 51,000 workers.

TABLE 6.9: TOTAL NET LABOR IMPACT OF A COMPENSATED DEFENSE SPENDING CUT

SELECTED INDUSTRIES	(Thousands of Jobs) INFORMATION INDUSTRIES	NON-INFORMATION INDUSTRIES
Gainers		
69 Wholesale & retail trade, net		276
77 Medical,educ svcs & nonprofit org,net		65
70* Finance & insurance: components	61	
77* Medical, educational, non-profits	51	
72 Hotels: personal & repair svcs, net		48
4 Agriculture, forest, fish services		46
2 Other agriculture products		45
1 Livestock & products		43
18 Apparel		38
69* Trade margin on information goods	37	
71 Rental & real estate, net		16
73* Misc business information services	11	
75 Automobile repair & services		10
26* Printing & publishing		10
Losers		
60 Aircraft and parts		- 84
56* Radio,TV,Commn. equipment	- 43	
13 Ordnance & accessories		- 42
57* Electronic components	- 21	
37 Primary iron & steel mfrg.		- 10
61 Other transportation equipment		- 10
TOTAL NET IMPACT	110	478

The aircraft industry loses 84,000 jobs; and the radio, television, and communications equipment industry loses 43,000--1,000 more than munitions and ordnance manufacturers. The electronics-component industry finds itself with an excess of 21,000 jobs; steel manufacturers lay off 10,000 workers; and transportation equipment manufacturers also lay off 10,000.

The labor impact on the information industries is mixed. Some industries, such as communications equipment manufacturers, are deeply enmeshed in the "military-information industry complex," and suffer serious losses. Others, such as financial services and education, are beneficiaries of cuts in defense spending. These estimates are qualitative in nature, and should not be interpreted too literally at this level of experimental realism.

Bottlenecks and Unanticipated Consequences

An important application of I-O techniques has been in uncovering capacity constraints or expansion bottlenecks. Also, I-O techniques have pointed some higher order consequences of a policy that were not intuitively obvious at first. Table 6.10 is a summary of the detailed reports in Appendix 6 (Vol. 8).

TABLE 6.10: SUMMARY OF EXPERIMENT I: NET OUTPUT AND EMPLOYMENT IMPACTS

INDUSTRIES	OUTPUT TOTAL IMPACTS	 DIRECT IMPACTS	 INDIRECT IMPACTS	EMPLOYMENT TOTAL IMPACTS	 DIRECT IMPACTS	 INDIRECT IMPACTS
INFORMATION INDUSTRIES		($ Millions)			(Thousands of Jobs)	
11*) Info buildings: office,education,comm.	-19.	-19.	0.	-1.	-1.	0.
12*) Maintenance & repair on info buildings	52.	0.	52.	2.	-0.	2.
23*) Office furniture & equipment	-5.	-2.	-3.	-0.	-0.	-0.
24*) Paper: printing (exc boxes)	39.	-2.	41.	1.	-0.	1.
26*) Printing & publishing	202.	102.	100.	10.	5.	5.
27*) Ink	3.	0.	3.	0.	-0.	0.
48*) Printing & paper machinery	-0.	-2.	1.	-0.	-0.	0.
51*) Computers,calculators,office equip.	-58.	-52.	-6.	-2.	-2.	-0.
53*) Electronic measuring instruments	-58.	-43.	-15.	-2.	-2.	-1.
56*) Radio, TV, comm'n equipment	-1112.	-1001.	-111.	-43.	-39.	-4.
57*) Electronic components	-447.	-140.	-308.	-21.	-7.	-15.
58*) Misc electronic instruments	-2.	-2.	-0.	-0.	-0.	-0.
62*) Mech measuring & control instruments	-145.	-91.	-54.	-7.	-4.	-3.
63*) Photographic & related equipment	-53.	-50.	-3.	-2.	-2.	-0.
64*) Advertising signs & displays	11.	6.	5.	1.	0.	0.
66*) Telecommunications, exc. radio & TV	199.	148.	51.	9.	7.	2.
67*) Radio, TV, CATV	17.	0.	17.	1.	-0.	1.
69*) Trade margin on info goods	383.	350.	33.	37.	34.	3.
70*) Finance & insurance: components	1065.	871.	193.	61.	50.	11.
71*) Real estate:fees,royalties,office rentals	386.	224.	162.	3.	1.	1.
72*) Repair: radio & TV equipment	35.	32.	3.	5.	4.	0.
73*) Misc business info services	253.	-139.	392.	11.	-6.	17.
76*) Motion pictures	58.	44.	13.	4.	3.	1.
77*) Medical, educational, nonprofit	435.	421.	14.	51.	50.	2.
78*) Postal service	27.	-7.	34.	4.	-1.	5.
82*) Office Supplies	4.	-20.	24.	0.	0.	0.
NON-INFORMATION INDUSTRIES						
1) Livestock & products	759.	68.	692.	43.	4.	39.
2) Other agricultural products	607.	115.	492.	45.	9.	37.
3) Forestry and fishery products	27.	12.	15.	1.	0.	0.
4) Agr., Forest, Fish Services	52.	2.	50.	5.	0.	5.

TABLE 6.10: SUMMARY OF EXPERIMENT I: NET OUTPUT AND EMPLOYMENT IMPACTS (Continued)

	OUTPUT			*EMPLOYMENT*		
INDUSTRIES	*TOTAL IMPACTS*	*DIRECT IMPACTS*	*INDIRECT IMPACTS*	*TOTAL IMPACTS*	*DIRECT IMPACTS*	*INDIRECT IMPACTS*
5) Iron & ferroalloy ores mining	-3.	14.	-17.	-0.	0.	-0.
6) Nonferrous metal ores mining	-33.	-13.	-19.	-1.	-0.	-1.
7) Coal mining	8.	-4.	12.	0.	-0.	1.
8) Crude petroleum and natural gas	119.	0.	119.	2.	-0.	2.
9) Stone & clay mining & quarrying	1.	0.	0.	0.	0.	0.
10) Chemical & fertilizer mineral min.	-4.	0.	-5.	-0.	0.	-0.
11) New construction, Net	-176.	-176.	0.	-6.	-6.	0.
12) Maintenance & repair construction	-1.	-195.	194.	-0.	-9.	9.
13) Ordnance and accessories	-1437.	-1384.	-52.	-42.	-41.	-2.
14) Food & kindred products	2255.	2176.	79.	46.	44.	2.
15) Tobacco manufactures	196.	194.	1.	2.	2.	0.
16) Fabrics, yarn & thread mills	265.	4.	262.	10.	0.	10.
17) Misc. textile goods & floor cover.	65.	41.	24.	2.	1.	1.
18) Apparel	580.	572.	8.	38.	37.	1.
19) Misc. fabricated textile products	18.	-7.	25.	1.	-0.	1.
20) Lumber, wood prod. exc. containers	-2.	4.	-6.	-0.	0.	-0.
21) Wooden containers	1.	-4.	6.	0.	-0.	0.
22) Household furniture	90.	109.	-19.	6.	7.	-1.
23) Other furniture, fixtures, Net	-3.	-1.	-2.	-0.	-0.	-0.
24) Paper, allied prod. exc containers, Net	132.	38.	94.	4.	1.	3.
25) Paperboard containers, boxes	63.	-4.	67.	2.	-0.	2.
26) Printing & publishing, Net	9.	-6.	15.	0.	-0.	1.
27) Chemicals, select Chem products, Net	-184.	-307.	122.	-4.	-6.	3.
28) Plastics, synthetic materials	37.	-13.	50.	1.	-0.	1.
29) Drugs, Cleaning, Toilet preparations	253.	199.	53.	5.	4.	1.
30) Paints & allied products	5.	1.	4.	0.	0.	0.
31) Petroleum refining & related ind's	176.	118.	58.	1.	1.	0.
32) Rubber & misc plastics products	43.	-5.	48.	2.	-0.	2.
33) Leather tanning, ind. leather prods.	24.	-1.	25.	2.	-0.	2.
34) Footwear & other leather products	113.	107.	6.	7.	7.	0.
35) Glass & glass products	32.	8.	24.	1.	0.	1.
36) Stone & clay products	-19.	3.	-22.	-1.	0.	-1.
37) Primary iron & steel manufacturing	-335.	-73.	-262.	-10.	-2.	-8.
38) Primary nonferrous metal manufacturing	-313.	-12.	-301.	-6.	-0.	-6.
39) Metal containers	56.	-3.	58.	1.	-0.	1.
40) Heating, plumbing & struc metal prods.	-62.	-35.	-27.	-2.	-1.	-1.
41) Stamping, screw mach. prods & bolts	-60.	-11.	-49.	-2.	-0.	-2.
42) Other fabricated metal products	-82.	-24.	-58.	-3.	-1.	-2.
43) Engines and turbines	-94.	-75.	-19.	-3.	-2.	-1.
44) Farm machinery & equipment	-1.	-4.	3.	-0.	-0.	0.

TABLE 6.10: SUMMARY OF EXPERIMENT I: NET OUTPUT AND EMPLOYMENT IMPACTS (Continued)

	OUTPUT			EMPLOYMENT		
INDUSTRIES	TOTAL IMPACTS	DIRECT IMPACTS	INDIRECT IMPACTS	TOTAL IMPACTS	DIRECT IMPACTS	INDIRECT IMPACTS
45) Const., mining & oil field machs.	-70.	-63.	-7.	-2.	-2.	-0.
46) Materials handling mach & equipment	-20.	-17.	-3.	-1.	-1.	-0.
47) Metalworking mach & equipment	-98.	-22.	-76.	-4.	-1.	-3.
48) Spec ind mach & equipment, Net	-1.	-4.	3.	-0.	-0.	0.
49) General ind mach & equipment	-101.	-53.	-49.	-4.	-2.	-2.
50) Machine shop products	-1[illegible].	-21.	-93.	-7.	-1.	-6.
51) Office comp & accounting machines	0.	0.	0.	0.	0.	0.
52) Service industry machines	-4.	-8.	4.	-0.	-0.	0.
53) Elec ind equip & apparatus, Net	-142.	-102.	-39.	-6.	-4.	-2.
54) Household appliances	101.	103.	-2.	3.	3.	-0.
55) Electric lighting & wiring equip.	-5.	10.	-15.	-0.	0.	-1.
56) Radio, television & comm. eqoip	0.	0.	0.	0.	0.	0.
57) Electronic components & access.	0.	0.	0.	0.	0.	0.
58) Misc elec machinery, Net	-24.	-20.	-3.	-1.	-1.	-0.
59) Motor vehicles & equipment	407.	407.	0.	8.	8.	0.
60) Aircraft and parts	-2228.	-1999.	-229.	-84.	-76.	-9.
61) Other transportation equipment	-255.	-249.	-5.	-10.	-10.	-0.
62) Scientific & controlling instru.	-10.	-16.	6.	-0.	-1.	0.
63) Optical, ophthalmic&photo equip, Net	6.	7.	-1.	0.	0.	-0.
64) Misc manufacturing, Net	143.	119.	24.	7.	6.	1.
65) Transportation & warehousing	-120.	-302.	182.	-6.	-16.	10.
66) Comm. exc radio&TV broadcasting	0.	0.	0.	0.	0.	0.
67) Radio & TV broadcasting	0.	0.	0.	0.	0.	0.
68) Electric,gas,water & sanitary svcs	564.	435.	128.	10.	8.	2.
69) Wholesale & retail trade, Net	2778.	2676.	102.	276.	266.	10.
70) Finance & insurance, Net	28.	20.	8.	2.	1.	0.
71) Real estate & rental, Net	2101.	1863.	238.	16.	14.	2.
72) Hotels:personal&rep svcs exc auto,Net	355.	325.	30.	48.	44.	4.
73) Business services, Net	-75.	-110.	36.	-4.	-6.	2.
74) (Research and Development)	0.	0.	0.	0.	0.	0.
75) Automobile repair & services	288.	225.	63.	10.	8.	2.
76) Amusements, Net	105.	98.	7.	8.	8.	1.
77) Medical,educ svcs&non-profit org, Net	580.	566.	14.	65.	63.	2.
78) Federal govt enterprises, Net	47.	-3.	49.	4.	-0.	4.
79) State & local govt enterprises	135.	26.	109.	6.	1.	5.
80) Imports	-296.	-288.	-7.	0.	0.	0.
81) Business travel, entertainment & gifts	43.	0.	43.	0.	0.	0.
82) Office supplies	0.	0.	0.	0.	0.	0.
TOTAL NON-INFORMATION	7294.	5030.	2265.	478.	355.	122.
TOTAL INFORMATION	1267.	628.	640.	121.	92.	29.
TOTAL	8564.	5658.	2905.	599.	447.	152.

It captures the total, direct, and indirect effects on both output and employment broken down by industry, and reveals some potential bottleneck problems.

Some industries, such as livestock (#1), are not directly impacted to any extent, but can receive large jolts from other industries. The livestock industry will see a direct requirement of about $68 million in new revenues--either generated by new final demand purchases or originating within the industry itself. This new revenue directly translates into about 4,000 new jobs--a tiny fraction of the industry's total work force. However, indirect impacts on the industry will be substantial--some $692 million in new output, which translates into 39,000 new jobs. If the industry does not anticipate these demands, it may become a "bottleneck" in the adjustment process from the old economy to the new.

The computer industry (51*) faces the opposite problem. The industry will expect to lose $58 million as a result of the spending cuts. Since consumers do not buy computers, a lost dollar in sales to the defense establishment is not recouped as a dividend in increased personal consumption. However, the computer industry need not brace itself against unknown ripple effects--most of the action will be directly felt inside the industry (-$52 million), with only a mild aftershock coming in cancelled orders from other industries (-$6 million). In employment terms, the industry will have to lay off 2,000 workers directly, and probably no more as the indirect effects are felt.

Some industries could be caught badly flatfooted. For example, the fabric industry (#16) will feel a very small $4 million direct impact. But eventually it will be hit with $262 million in new output requirement, and will have to hire 10,000 new workers to satisfy new demand.

The more capital intensive the industry, the harder it is to gracefully increase or decrease capacity in the short run. In a rapidly changing environment, ignorance about higher order--or indirect--effects can throw a wrench into balanced growth programs. Here input-output analysis can be quite useful.

Experiment II - Doubling Investment in Information Capital

Experiment II, like its predecessor, is not a fine-tuned policy instrument. Rather, its purposes are to say something general about the relationship between the information industries and the overall economy.

In this experiment, I ask the following question: "Holding total investment constant, what is the impact on the economy of doubling investment expenditures (or gross capital formation) in information capital goods?" Investment is instantaneously shifted to information capital (e.g., office buildings, printing presses and computers), and away from noninformation capital (e.g., factories, stamping machines, trucks). Three interpretations are in order:

(i) the experiment ignores the fact that some types of capital move as complements.

(ii) the experiment ignores the externalities associated with the existence of information resources. The creation of a telecommunication or a computer network creates many more jobs than indicated in a simple impact study.

(iii) the experiment does not explicitly address technical change. New configurations of information capital could result in expansions of the production frontier; no attempt has been made to represent such technical changes. This experiment assumes static technology.

TABLE 6.11: SUMMARY OF THE EXPERIMENTAL CHANGES IN GROSS CAPITAL FORMATION (GCF)

	($ Millions, 1967)		
	CONTROL ECONOMY	EXPERIMENTAL ECONOMY	NET CHANGE IN GCF
Information GCF	18,673	37,346	+ 18,673
Non-information GCF	94,689	76,016	- 18,673
Total GCF	113,362	113,362	0

The procedure is outlined in Table 6.11. Total gross capital formation remains unchanged before and after the experiment (at $113.4 billion). However, the information capital industries have doubled their output, from $18.7 billion to $37.4 billion; and the noninformation capital industries have cut back their sales to final demand by the same amount--$18.7 billion.

Summary of Experiment II

Table 6.12 contains an overview of the experimental impacts on output and labor. The total net impact on the economy was a mild recession of around $2.4 billion in lost output and 52,000 lost jobs. Although the information capital producers generated $21.5 billion of new output (on an increased final demand of $18.7 billion), the noninformation industries lost $23.8 billion, for a net loss of around $2.4 billion in output. This result is correct from a strictly engineering viewpoint. However, it ignores any externalities that may be generated for the rest of the economy. The creation of a new national data network does not create a large impact on other industries because its material requirements are modest. If it uses microwave and satellite technologies, the investment project might generate very little interindustry transactions. But the existence of such a network could stimulate productivity throughout the economy. This more subtle effect is not captured by this version of the experiment.

TABLE 6.12:

NET IMPACT ON OUTPUT AND EMPLOYMENT OF DOUBLING GROSS CAPITAL FORMATION IN INFORMATION CAPITAL

	($ Millions, 1967)			(Thousands of Jobs, 1967)		
	OUTPUT			EMPLOYMENT		
	Total	Direct	Indirect	Total	Direct	Indirect
Total	-2,362	-246	-2,118	-52	34	-85
Information Inds.	21,513	19,676	1,836	862	781	81
Non-Information Inds.	-23,875	-19,922	-3,954	-914	-747	-166

The employment losses reflect the recessionary impact of the experiment. The information industries created 862,000 new jobs; the noninformation industries lost 914,000 jobs; and the net impact was a loss of 52,000 jobs to the labor force. Even at this overview level, some interesting insights emerge. The information-capital producing industries employ more labor per dollar of output than other capital goods manufacturers. The direct employment impact produced more jobs in the information industries (781,000) than were lost in the noninformation industries (747,000). The direct effect created 34,000 jobs. However, the noninformation industries are linked through longer interindustry production chains. Indirectly, 166,000 jobs were lost in the noninformation industries, more than twice as many as were gained indirectly in the information industries. Whereas 9.4% of the information industries labor gains were indirect, 18.2% of the noninformation labor was lost through an economy wide "ripple."

As with Experiment I, a rich amount of industry detail is available. The output and employment changes can be decomposed by industry into direct and indirect effects, and the net results of the experiment can be shown. To conserve space, only one summary table is presented; all the detailed reports appear in Appendix 6 (Vol. 8). Table 6.13 shows the total, direct, and indirect net effects of the experiment on both output and employment by industry.

TABLE 6.13: SUMMARY OF EXPERIMENT II: NET OUTPUT AND EMPLOYMENT IMPACTS

	OUTPUT			*EMPLOYMENT*		
INDUSTRIES	*TOTAL IMPACTS*	*DIRECT IMPACTS*	*INDIRECT IMPACTS*	*TOTAL IMPACTS*	*DIRECT IMPACTS*	*INDIRECT IMPACTS*
INFORMATION INDUSTRIES	*($ Millions)*			*(Thousands of Jobs)*		
11*) Info buildings: office,education,comm.	5674.	5674.	0.	201.	201.	0.
12*) Maintenance & repair on info buildings	33.	0.	33.	2.	-0.	2.
23*) Office furniture & equipment	654.	654.	-1.	33.	33.	-0.
24*) Paper: printing (exç boxes)	25.	0.	25.	1.	-0.	1.
26*) Printing & publishing	95.	0.	95.	5.	0.	5.
27*) Ink	2.	0.	2.	0.	-0.	0.
48*) Printing & paper machinery	668.	671.	-3.	24.	25.	-0.
51*) Computers,calculators,office equip.	3914.	3869.	45.	140.	138.	2.
53*) Electronic measuring instruments	703.	654.	49.	29.	27.	2.
56*) Radio, TV, comm'n equipment	3284.	3161.	123.	126.	122.	5.
57*) Electronic components	1352.	22.	1331.	64.	1.	63.
58*) Misc electronic instruments	143.	141.	2.	5.	5.	0.
62*) Mech measuring & control instruments	683.	669.	14.	33.	32.	1.
63*) Photographic & related equipment	1007.	981.	26.	33.	32.	1.
64*) Advertising signs & displays	253.	250.	3.	12.	12.	0.
66*) Telecommunications, exc. radio & TV	1136.	1107.	30.	50.	49.	1.
67*) Radio, TV, CATV	2.	0.	2.	0.	-0.	0.
69*) Trade margin on info goods	965.	1020.	-55.	93.	99.	-5.
70*) Finance & insurance: components	29.	5.	24.	2.	0.	1.
71*) Real estate:fees,royalties,office rentals	835.	797.	38.	5.	5.	0.
72*) Repair: radio & TV equipment	1.	0.	1.	0.	-0.	0.
73*) Misc business info services	29.	0.	29.	1.	-0.	1.
76*) Motion pictures	3.	0.	3.	0.	-0.	0.
77*) Medical, educational, nonprofit	5.	0.	5.	1.	-0.	1.
78*) Postal service	6.	0.	6.	1.	-0.	1.
82*) Office Supplies	9.	0.	9.	0.	0.	0.
NON-INFORMATION INDUSTRIES						
1) Livestock & products	-2.	0.	-2.	-0.	-0.	-0.
2) Other agricultural products	-16.	0.	-16.	-1.	-0.	-1.
3) Forestry and fishery products	-52.	0.	-52.	-2.	-0.	-2.
4) Agr., Forest, Fish Services	-16.	0.	-16.	-2.	-0.	-2.
5) Iron & ferroalloy ores mining	-55.	0.	-55.	-1.	-0.	-1.
6) Nonferrous metal ores mining	3.	0.	3.	0.	-0.	0.
7) Coal mining	-31.	0.	-31.	-1.	0.	-1.
8) Crude petroleum and natural gas	-68.	0.	-68.	-1.	-0.	-1.
9) Stone & clay mining & quarrying	-104.	0.	-104.	-5.	-0.	-5.
10) Chemical & fertilizer mineral min.	-2.	0.	-2.	-0.	-0.	-0.
11) New construction, Net	-9597.	-9597.	0.	-351.	-351.	0.
12) Maintenance & repair construction	15.	0.	15.	1.	-0.	1.
13) Ordnance and accessories	17.	-5.	23.	1.	-0.	1.
14) Food & kindred products	26.	0.	26.	1.	-0.	1.
15) Tobacco manufactures	2.	0.	2.	0.	-0.	0.
16) Fabrics, yarn & thread mills	-44.	0.	-44.	-2.	0.	-2.
17) Misc. textile goods & floor cover.	-57.	-19.	-38.	-1.	-0.	-1.
18) Apparel	-7.	0.	-7.	-0.	-0.	-0.
19) Misc. fabricated textile products	-35.	0.	-35.	-1.	-0.	-1.
20) Lumber, wood prod. exc. containers	-663.	-2.	-662.	-33.	-0.	-33.
21) Wooden containers	0.	0.	0.	0.	0.	0.
22) Household furniture	-25.	-33.	8.	-2.	-2.	1.
23) Other furniture, fixtures, Net	-166.	-201.	35.	-8.	-10.	2.

SUMMARY OF EXPERIMENT II: NET OUTPUT AND EMPLOYMENT IMPACTS (Continued)

INDUSTRIES	OUTPUT TOTAL IMPACTS	OUTPUT DIRECT IMPACTS	OUTPUT INDIRECT IMPACTS	EMPLOYMENT TOTAL IMPACTS	EMPLOYMENT DIRECT IMPACTS	EMPLOYMENT INDIRECT IMPACTS
24) Paper, allied prod. exc containers, Net	51.	0.	51.	1.	0.	1.
25) Paperboard containers, boxes	27.	0.	27.	1.	-0.	1.
26) Printing & publishing, Net	5.	0.	5.	0.	-0.	0.
27) Chemicals, select Chem products, Net	23.	0.	23.	0.	-0.	0.
28) Plastics, synthetic materials	5.	0.	5.	0.	-0.	0.
29) Drugs, Cleaning, Toilet preparations	-2.	0.	-2	-0.	-0.	-0.
30) Paints & allied products	-37.	0.	-37.	-1.	-0.	-1.
31) Petroleum refining & related ind's	-149.	0.	-149.	-1.	-0.	-1.
32) Rubber & misc plastics products	-34.	-6.	-28.	-1.	-0.	-1.
33) Leather tanning, ind. leather prods.	-1.	0.	-1.	-0.	-0.	-0.
34) Footwear & other leather products	0.	0.	0.	0.	-0.	0.
35) Glass & glass products	54.	0.	54.	3.	0.	3.
36) Stone & clay products	-412.	0.	-412.	-17.	0.	-17.
37) Primary iron & steel manufacturing	-1107.	0.	-1107.	-33.	-0.	-33.
38) Primary nonferrous metal manufacturing	127.	-10.	137.	3.	-0.	3.
39) Metal containers	-7.	-2.	-5.	-0.	-0.	-0.
40) Heating, plumbing & struc metal prods.	-537.	-190.	-347.	-21.	-7.	-14.
41) Stamping, screw mach. prods & bolts	-107.	0.	-107.	-4.	-0.	-4.
42) Other fabricated metal products	-203.	-70.	-134.	-8.	-3.	-5.
43) Engines and turbines	-299.	-158.	-142.	-8.	-4.	-4.
44) Farm machinery & equipment	-631.	-611.	-20.	-20.	-19.	-1.
45) Const., mining & oil field machs.	-586.	-508.	-78.	-18.	-16.	-2.
46) Materials handling mach & equipment	-238.	-231.	-7.	-8.	-8.	-0.
47) Metalworking mach & equipment	-759.	-739.	-20.	-32.	-31.	-1.
48) Spec ind mach & equipment, Net	-542.	-545.	3.	-20.	-20.	0.
49) General ind mach & equipment	-606.	-403.	-203.	-23.	-15.	-8.
50) Machine shop products	-35.	-1.	-34.	-2.	-0.	-2.
51) Office comp & accounting machines	0.	0.	0.	0.	0.	0.
52) Service industry machines	-409.	-366.	-43.	-10.	-9.	-1.
53) Elec ind equip & apparatus, Net	-437.	-486.	49.	-18.	-20.	2.
54) Household appliances	-81.	-26.	-55.	-3.	-1.	-2.
55) Electric lighting & wiring equip.	65.	14.	78.	3.	-1.	4.
56) Radio, television & comm. eqoip	0.	0.	0.	0.	0.	0.
57) Electronic components & access.	0.	0.	0.	0.	0.	0.
58) Misc elec machinery, Net	-59.	-16.	-43.	-2.	-1.	-2.
59) Motor vehicles & equipment	-2567.	-2500.	-67.	-48.	-47.	-1.
60) Aircraft and parts	-564.	-595.	31.	-21.	-23.	1.
61) Other transportation equipment	-742.	-720.	-22.	-29.	-28.	-1.
62) Scientific & controlling instru.	-91.	-104.	13.	-4.	-5.	1.
63) Optical, ophthalmic&photo equip, Net	7.	0.	7.	0.	-0.	0.
64) Misc manufacturing, Net	-60.	-62.	2.	-3.	-3.	0.
65) Transportation & warehousing	-449.	-184.	-265.	-24.	-10.	-14.
66) Comm. exc radio&TV broadcasting	0.	0.	0.	0.	0.	0.
67) Radio & TV broadcasting	0.	0.	0.	0.	0.	0.
68) Electric, gas, water & sanitary svcs	-62.	0.	-62.	-1.	0.	-1.
69) Wholesale & retail trade, Net	-1347.	-1121.	-227.	-134.	-111.	-22.
70) Finance & insurance, Net	2.	0.	2.	0.	0.	0.
71) Real estate & rental, Net	-164.	-267.	104.	-1.	-2.	1.
72) Hotels: personal&rep svcs exc auto, Net	27.	0.	27.	4.	-0.	.
73) Business services, Net	-16.	0.	-16.	-1.	-0.	1.
74) (Research and Development)	0.	0.	0.	0.	0.	0.
75) Automobile repair & services	-47.	0.	-47.	-2.	0.	-2.
76) Amusements, Net	2.	0.	2.	0.	-0.	0.

SUMMARY OF EXPERIMENT II: NET OUTPUT AND EMPLOYMENT IMPACTS (Continued)

INDUSTRIES	OUTPUT TOTAL IMPACTS	OUTPUT DIRECT IMPACTS	OUTPUT INDIRECT IMPACTS	EMPLOYMENT TOTAL IMPACTS	EMPLOYMENT DIRECT IMPACTS	EMPLOYMENT INDIRECT IMPACTS
77) Medical,educ svcs&non-profit org, Net	2.	0.	2.	0.	-0.	0.
78) Federal govt enterprises, Net	-4.	0.	-4.	-0.	-0.	-0.
79) State & local govt enterprises	-13.	0.	-13.	-1.	-0.	-1.
80) Imports	-83.	-130.	47.	0.	0.	0.
81) Business travel, entertainment & gifts	93.	0.	93.	0.	0.	0.
82) Office supplies	0.	0.	0.	0.	0.	0.
TOTAL NON-INFORMATION	-23875.	-19922.	-3954.	-914.	-747.	-166.
TOTAL INFORMATION	21513.	19676.	1836.	862.	781.	81.
TOTAL	-2361.	-246.	-2118.	-52.	33.	-86.

Structural Depth

Another purpose of this simple experiment is to gauge how "deep" the information infrastructure is relative to other noninformational types of capital. The deeper a capital producing industry, the greater will be the effect on the economy of a change in that industry's final demand. Small changes in a very deep sector can cause grave higher order effects (on other industries in the economy). Conversely, major changes in the inputs of a shallow sector can cause relatively few dislocations in the rest of the economy. The issue of structural depth is important to an economic planner who must be simultaneously concerned with maximizing national income, targeting for full employment, and maintaining balanced growth between the major sectors of the economy. In regional analysis, balanced growth takes the form of uniform employment gains and industrial development in different parts of the country. Input-Output can be successfully used for such policy concerns, and the example discussed below is a very simple attempt to illustrate how structural depth can be estimated.

If an industry is structurally deep, it will show a larger output "ripple" effect given a change in final demand than will a shallow sector. If we are dealing strictly in output terms, this means that deep industries have higher direct and indirect output/final demand ratios than do the shallow industries. The relevant statistic describing structural depth is represented as follows:

$$\frac{AX + D}{D} = \frac{\text{Total output}}{\text{Final demand}}$$

Table 6.14 shows a summary of the output/final demand "multipliers."

TABLE 6.14:

EXAMINING THE STRUCTURAL DEPTH OF INFORMATION AND NON-INFORMATION INDUSTRIES

	TOTAL OUTPUT/ FINAL DEMAND MULTIPLIER	DIRECT OUTPUT/FD MULTIPLIER	INDIRECT OUTPUT/FD MULTIPLIER
INFORMATION INDUSTRIES	1.15	1.05	0.10
NON-INFORMATION INDUSTRIES	1.28	1.07	0.21

The total multiplier effect on the noninformation industries (1.28) is somewhat higher than the information industries' multiplier (1.15), indicating that noninformation capital is a somewhat deeper sector overall. The direct multipliers were essentially the same (1.05 vs. 1.07). But the big difference was due to the indirect effects--the noninformation industries created twice the ripple on the rest of the economy compared to the information industries. These results reflect the 1967 economy.

Structural depth can similarly be measured for other sectors of final demand. We started with the investment sector since it is intuitively clear that certain types of capital formation will lead to higher output and employment than others. However, this is also true for personal consumption, government purchases, and exports. Policy actions on personal income tax, income transfers, government procurement, revenue-sharing programs and international trade will result in differential impacts depending on the structural depth of the effected industries.

Employment Impact Studies

A complete employment impact study would include breakdowns of total employment requirements (i) by occupational type, and (ii) by region. Although this level of detail is well beyond the scope of this thesis, it is within the capability of the I-O matrix techniques and other data bases which have been discussed.

We know from Table 6.13 that the computer industry (51*) will find a requirement for 140,000 additional jobs as a result of the experimental shift in investment. The Bureau of Labor Statistics has developed (with the Census Bureau) an "Industry by Occupation" matrix which lists the location of 440 different occupational types in 201 industries. We have separated the matrix into information workers and noninformation workers.

We know the exact occupational composition of the computer industry in great detail. By using some simplifying assumptions, the 140,000 jobs can be broken down into the 440 types of occupational titles listed in the matrix. The limitation of this approach is common to all input-output techniques--the problem of substitution and nonlinearity. Industry expansion or contraction could result in an unequal demand for different occupations. For example, the proportion of new top-management jobs to new output may be much lower than the ratio of new assembly and fabrication jobs to new output in the short run. A proportionate scaling would ignore this effect.

Cast as "labor elasticities of demand," the inequality is represented as follows:

$$(1) \quad \frac{d\ (\log L)_i}{d\ (\log Q)_r} \neq \frac{d\ (\log L_j)}{d\ (\log Q_r)}$$

Where i, j are two occupations, r is a particular industry

A fair method of using a detailed labor impact study is to develop a full set of elasticities.[5] Since this is impractical, detailed impact studies usually offer a first-cut look at the expected labor needs, without making excessive claims for accuracy.

Another well-known application of a labor impact study involves regional analysis. Here, the output of an industry is dispersed among the different regions of the country. Some investigators have used as many as 20 regions. In principle, a multiregion I-O model can be extended down to the basic census accounting unit--a township or county; in practice, only multistate regions are used. For example, the output of the computer industry could be allocated to California, Texas, Minnesota, and New York; or to the West, North, South, and East. Output requirements can then be directly translated into job impacts in each region. For highly concentrated industries, a "region" could actually serve as a close surrogate for one dominant firm. For example, the Minnesota region "computer industry" essentially covers just Control Data Corporation plus a few ancillary firms. Impact studies of this sort have been used quite effectively in predicting impacts on large firms that dominate a particular city or region.

Matching Jobs with the Unemployed

Another application that flows naturally from the previous two has not, to my knowledge, been developed. Rather than starting with a policy experiment and tracing the effects on unemployment, the chain of events can be reversed. The usual method "creates" jobs experimentally, and the analyst's role is to see if the labor force can satisfy the new requirements. For dealing with employment experiments, one could start with an inventory of unemployed people classified by detailed occupation. The task would then be to generate the least amount of final demand that absorbs the greatest number of those identified as unemployed. The method is simply a linear programming application combined with I-O analysis, as follows:

$$(2) \quad \max L\,(f_1, f_2, \ldots, f_n)$$

$$\text{s.t.} \quad l_1 \leq \bar{l}_1$$

$$l_2 \leq \bar{l}_2$$

$$l_n \leq \bar{l}_n$$

$$l_i \geq 0$$

Where L is the total labor force; f_i are the eleven final demand sectors which can be manipulated (e.g., government purchases of wage services); l_i are the new (computed) labor requirements; l_i are the old (control) levels of employment in each occupation; and the constraint that all l_i are positive, although they may be smaller than l_i, the original jobs in occupation i.

This method allows the analyst to "back into" a desired program of government expenditures that utilizes the greatest number of (known) idle workers rather than first creating jobs and then checking whether there are unemployed to fill them. Applications in training and vocational programs are clear.

FOOTNOTES

[1] There are at least four meanings of "direct" and "indirect" impacts. For a review, see A. Parikh, "Various Definitions of Direct and Indirect Requirements in Input-Output Analysis," *Review of Economics and Statistics*, August 1975, pp. 375-377. The two most common are: (i) counting "direct" as all intraindustry effects (i.e., the main diagonal coefficients); or (ii) counting only the net final demand for the industry's output (e.g., all 1.0 on the main diagonal). We use the first definition.

[2] See for example, D. Jorgenson and Z. Griliches, "The Explanation of Productivity Change," *Survey of Current Business*, Vol. 52, No. 5, Part II, May 1972.

[3] W. Leontieff and M. Hoffenberg, "The Economic Effects of Disarmament," 1961, in *Input-Output Economics*, Oxford University Press, New York, 1966.

[4] See Bureau of Labor Statistics, "Manpower Impact of Federal Government Programs: Selected Grants-in-Aid to State and Local Governments" (Report 424, 1973); Also "Factbook for Estimating the Manpower Needs of Federal Programs" (Bulletin #1832); Also, an NSF project produced by the BLS on "Impact of Federal Pollution Control and Abatement Expenditures on Manpower Requirements" (Bulletin #1836); See also, I. Stern, "Industry Effects of Government Expenditures: An Input-Output Analysis," *Survey of Current Business*, May 1975, Vol 55, No. 5.

[5] See C. Almon Jr., *The American Economy to 1975*, Harper & Row, New York, 1966, pp. 31-43.

CHAPTER SEVEN

INFORMATION OCCUPATIONS

> Planning, in short, requires a great variety of information. It requires variously informed men and women who are suitably specialized in obtaining the requisite information...those who have knowledge to plan price strategies...those who, at a higher level of technology, are so informed that they can work effectively with the state to see that it is suitably guided; and those who can organize the flow of information. Finally, following from the need for this variety of specialized talent, is the need for its coordination...information must be extracted from the various specialists, tested for its reliability and relevance, and made to yield a decision.
>
> J. K. Galbraith, The New Industrial State
> Houghton-Mifflin, Boston, 1971 (Secon Ed.)

Fritz Machlup and Daniel Bell focused early on the structure of the U.S. work force as a basic indicator of a "postindustrial" or a "knowledge" society. They developed summary statistics from the census of population, showing the growth in professional, technical, and clerical occupations relative to blue-collar or crafts occupations. Both authors couch their conclusions as tentative, calling for a much more detailed study of the U.S. labor force. Machlup[1] states,

> "The reliability of the data with which we worked must not be overestimated, and the legitimacy of several of the uses we made of them must be questioned. Indeed some of the statistical procedures were accepted only as makeshifts in the hope that others may improve upon our most imperfect efforts." (p. 400)

This chapter is one effort to dissect at the most tedious level the labor statistics underlying the phenomenon of "the information sector." Employee compensation and proprietors' income are analyzed in detail for 1967. Time series of the information workers in the U.S. labor force are built spanning the agricultural age (1860) to the present. Hopefully, these summary figures will be somewhat more instructive than the backup statistics; but the latter are available in Appendix 7 (Vols. 6, 7, 8) to any future researchers interested in continuing this line of investigation.

Bell[2] summarizes how a transition to a postindustrial economy affects the work force:

> "In preindustrial societies--still the condition of most of the world today--the labor force is engaged overwhelmingly in the extractive industries: mining, fishing, forestry, agriculture. Life is primarily a game against nature.... Industrial societies--principally those around the North Atlantic littoral plus the Soviet Union and Japan--are goods-producing societies. Life is a game against fabricated nature. The world has become technical and rationalized. The machine predominates, and the rhythms of life are mechanically paced .... A postindustrial society is based on services. What counts is not raw muscle power, or energy, but information." (pp. 126-127)

The relative size of the occupations engaged in agricultural manufacturing, and informational activities is an indicator of the economy which supports the work force. It shows how "specialized" the economy has become in the provision of things that make life possible, that make life pleasant, or that make life human. Knowledge or information can indeed be a primary "good," as we have seen in Chapter 3, and information is a persistent and valuable nonmarket commodity in the sense argued in Chapter 9.

In this chapter, I attempt to answer several questions. Who are the information workers and on what basis are they selected? What share of the U.S. wage bill is earned by information workers? How has the information sector of the labor force grown over time? What is the exact occupational structure of the labor force broken down by industry? What is the information labor component of noninformation industries?

THE INFORMATION WORKERS

Stating precisely who is an information worker and who is not is a risky proposition. Obviously, every human endeavor involves some measure of information processing and cognition; intellectual content is present in every task no matter how mundane. It is, after all, the critical difference between humans and animals that the former can process symbolic information quite readily while the latter cannot. There is nothing to be gained by saying that certain occupations have a zero informational content while others are purely informationl.

We are trying to get at a different question: Which occupations are primarily engaged in the production, processing, or distribution of information as the output, and which occupations perform information processing tasks as activities ancillary to the primary function? To make the question clear, is there a qualitative difference on the issue of information between a computer programmer and a carpenter? Both are skilled workers, earning roughly the same salary. Both require a certain amount of education before they can function productively. And both use attention, concentration, and applied knowledge in their respective tasks. However, the programmer's livelihood originates with the provision of an information service (a set of instructions to a computer), while the carpenter's livelihood originates with the construction of a building or a piece of furniture--noninformational goods. The former sells information as a commodity; the latter sells a tangible physical product.

I have developed a conceptual scheme for classifying information workers, presented as an overview in Table 7.1. The scheme was developed with a theoretical concern in mind and divides occupations into three major classes.

The first, "Markets for Information," includes those workers whose output or primary activity is an information product. Information is produced and sold as output and often assumes the form of a knowledge commodity.

The second major class of workers provides "Information in Markets." Their output is not knowledge for sale, but rather they serve as information gatherers and disseminators. These workers move information within firms and within markets--they search, coordinate, plan, and process market information.

The last class is the "Information Infrastructure" workers, whose occupations involve operating the information machines and technologies to support the previous two activities.

The data on employee compensation reported in Tables 7.2 and 7.7 were developed for this project, and appear in Appendix 7 (Vol. 6) as the "Employee Compensation Matrix (1967)." The sources and methods used to develop the data are also discussed in the Appendix.

Knowledge Producers

Knowledge producers, shown in Table 7.2, fall into two classes of workers--scientific and technical, and producers of private information services.

"Scientific and Technical Workers" are often engaged in inventive activity. A large portion of this marketplace for knowledge is part of the "grants economy," subsidized from the public or philanthropic purse. The scientific community generally shares new knowledge universally through the invisible college and through international scientific publications. Even when research scientists work for private industry, their knowledge outputs eventually take on a "publicness" unlike any other occupation. When a corporate research scientist invents something useful it eventually becomes public knowledge either through academic channels or through the disclosure requirements of filing a patent. This class of workers is at the heart of Machlup's definition of a "knowledge sector" in our society. The relevant policy questions in this sector focus on appropriability of one's efforts (i.e., property rights and the "publicness" nature of intellectual output), social allocation of resources to invention, and the distribution or utilization patterns of technical and scientific knowledge once it has been produced.

TABLE 7.1: TYPOLOGY OF INFORMATION WORKERS AND 1967 COMPENSATION[a]

	Employee Compensation ($ Millions)
MARKETS FOR INFORMATION	
KNOWLEDGE PRODUCERS	46,964
Scientific & Technical Workers	18,777
Private Information Services	28,187
KNOWLEDGE DISTRIBUTORS	28,265
Educators	23,680
Public Information Disseminators	1,264
Communication Workers	3,321
INFORMATION IN MARKETS	
MARKET SEARCH & COORDINATION SPECIALISTS	93,370
Information Gatherers	6,132
Search & Coordination Specialists	28,252
Planning and Control Workers	58,986
INFORMATION PROCESSORS	61,340
Non-Electronic Based	34,317
Electronic Based	27,023
INFORMATION INFRASTRUCTURE	
INFORMATION MACHINE WORKERS	13,167
Non-Electronic Machine Operators	4,219
Electronic Machine Operators	3,660
Telecommunication Workers	5,288
TOTAL INFORMATION	243,106
TOTAL EMPLOYEE COMPENSATION	454,259[b]
INFORMATION AS % OF TOTAL	53.52%

---

[a] Employee compensation includes wages and salaries and supplements.

[b] Excluding military workers.

Source: Computed using BLS Occupation by Industry matrix, Census of Population average wages. See Appendix 6 for the full Employee Compensation matrix and a narrative on how it was produced.

TABLE 7.2: KNOWLEDGE PRODUCERS

	1967 Employee Compensation ($ Millions)
Scientific & Technical Workers	18,777
Natural & Physical Sciences	2,181
Agricultural Scientists	108
Atmospheric, Space Scientists	71
Biological Scientists	260
Chemists	1141
Geologists	266
Marine Scientists	34
Physicists and Astronomers	275
Life, Physical Scientists	26
Mathematical Sciences	2,239
Mathematicians	95
Statisticians	194
Operations, Systems Research	811
Research Workers	1139
Social Sciences	1,327
Economists	805
Political Scientists	25
Psychologists	324
Sociologists	10
Urban & Regional Planners	96
Other Social Scientists	67
Engineering	13,030
Engineers, Aero-Astronautic	804
Engineers, Chemical	640
Engineers, Civil	1923
Engineers, Electrical	3334
Engineers, Industrial	1766
Engineers, Mechanical	2233
Engineers, Metallurgical	180
Engineers, Mining	54
Engineers, Petroleum	146
Engineers, Sales	475
Engineers, Other	1475
Private Information Service Providers	28,187
Counselors and Advisors	14,632
Lawyers	2275
Farm Management Advisors	64
Foresters, Conservationists	324
Home Management Advisors	36
Vocational, Education Counselors	952
Judges	246
Personnel Labor Relations	2707
Architects	588
Therapists	515
Dietitians	156
Physicians (50%)	1644
Designers	1055
Draftsmen	2464
Social Workers	1606
Computer Specialists	2,675
Computer Programmers	1551
Other Computer Specialists	163
Computer Systems Analysis	936
Numerical Tool Programmers	25
Financial Specialists	10,880
Accountants	5816
Bank, Financial Managers	4470
Creditmen	531
Actuaries	63
TOTAL KNOWLEDGE PRODUCERS	46,964

The second class of knowledge workers produce a wide variety of "private information services." This class includes lawyers, architects, computer programmers, and accountants. These occupations do not produce new knowledge but rather they apply old knowledge in ways which are specific to a particular client or situation. They sell knowledge "packages"--repackaging old knowledge in unique applications. Such markets tend always to be private, and function very well without the publicness aspects discussed above.

One of the most difficult (and lucrative) problems in an information-rich world is developing skills to package information that is useful: in the right form, at the right place, and at the right time. This problem is true whether information is being sold as a commodity in a recognizable marketplace (e.g., legal services), or whether the information is strictly for internal use (e.g., management information system). Particularly in "markets for information," the value of the service resides precisely in the worker's ability to package information in a uniquely useful way. Where there is a massive repository of preexisting knowledge plus a codified scheme for bringing the knowledge to bear on a particular problem, private information markets will work very well. Legal and medical consulting are the most obvious examples. The specialist does not create new knowledge; but a layperson cannot apply the publicly available knowledge without an information intermediary. Where "packaging" of extant knowledge can be routinized, information machines can be expected to play an ever-increasing role as augmenters of human skill. Lawyers and doctors are already beginning to make use of computers in their analytic and diagnostic work.

The cost of these two classes of knowledge production in 1967 was $47.0 billion. Around $18.8 billion was spent on scientists and technical workers, and about $28.2 billion on private information services.

Knowledge Distributors

Knowledge distributors fall into three occupational classes: (i) educators, (ii) public information disseminators, and (iii) communication workers. A detailed breakdown is shown in Table 7.3.

"Educators," as opposed to the scientific community, are mainly considered as providing public distribution of already produced knowledge. University educators also produce knowledge, in the form of scholarly research. No attempt is made to allocate their time between the two activities.

"Public information disseminators" include librarians and archivists. Whether these people work in public libraries or in privately financed (corporate) libraries, their services are in the provision of a "free good" to the user community--distribution of knowledge. Whether society allocates sufficient resources for this public good is a matter of much debate.

TABLE 7.3: KNOWLEDGE DISTRIBUTORS

	1967 Employee Compensation ($ Millions)	
Educators	23,680	
Adult Education Teachers		426
Agriculture Teachers		58
Art, Drama, Music Teachers		268
Atmospheric, Earth Marine Teachers		48
Biology Teachers		226
Business, Commerce Teachers		154
Chemistry Teachers		190
Economic Teachers		131
Education Teachers		86
Elementary School Teachers		8902
Engineering Teachers		219
Englist Teachers		365
Foreign Language Teachers		176
Health Specialties Teachers		386
History Teachers		170
Home Economics Teachers		31
Law Teachers		51
Mathematics Teachers		277
Physics Teachers		165
Preschool, Kindergarten Teachers		536
Psychology Teachers		156
Secondary School Teachers		7692
Sociology Teachers		72
Social Science Teachers		144
Miscellaneous College & University Teachers		195
College, University NEC		1426
Theology Teachers		38
Trade, Industrial Teachers		26
Teachers, Exc. College, University		567
Teachers Aides, Exc. Monitors		422
Coaches, Phys Ed Teachers (50%)		77
Public Information Disseminators	1,264	
Librarians		755
Archivists and Curators		44
Library Attendants, Assistant		465
Communication Workers	3,321	
Writers, Artists, Entertainers		528
Editors and Reporters		1288
Photographers		391
Authors		146
Public Relations People, Writers		802
Radio, TV Announcers		166
TOTAL KNOWLEDGE DISTRIBUTORS	28,265	

"Communications workers" include a number of occupations in the established news and entertainment media--newspapers, magazines, radio, film, and television. Although journalists engage in knowledge producing activities, such as investigative or analytic reporting, their instrument is a distributive medium.

In 1967, this group of occupations earned $28.3 billion, with over $23 billion earned by educators.

Market Search and Coordination Specialists

The requirements of organizing firms and markets involve several types of information. Information about the market environment is gathered by firms: prices, supply and demand conditions, the intentions of other firms, new technologies, and condition of other relevant markets (such as labor and capital markets). Also, firms engage in a tremendous amount of in-house information processing--such as planning, coordinating, and controlling the enterprise; meeting the informational needs of governments (forms and reports), of other firms (business communication), and of households (invoices, catalogs). Table 7.4 presents a breakdown of the market search and coordination specialists, whose knowledge production services are market specific. This group creates, supports, and maintains the market information system.

"Information gatherers" include a variety of occupations involved in the form of intelligence or simple investigatory work. Their job is to discover something about the state of the world--the extent of damage on an insurance claim, the value of a piece of property, the reading on a utility meter.

"Search and coordination specialists" operate entirely in the exchange marketplace. I have divided this class into three groups. On the "buy side" are buyers and purchasing agents whose job is to search the exchange market for the best possible good or service available. On the "sell side" are all the occupations whose job is to distribute relevant market information--prices, product characteristics, delivery schedules, and so on. And operating as both buyers and sellers simultaneously are the "brokers," whose income is earned exclusively by performing search activities on behalf of both sides of the market. These three groups earned over $28 billion in 1967.

"Planning and control workers" include all occupations which serve in administrative or managerial roles. Under administrators are public and private bureaucrats, school administrators, and office managers. Also included in this category are a variety of process-control supervisors, such as expediters and air-traffic controllers.

The administrative and managerial work force is the main engine of any organization. In public bureaucracies its job is to implement programs legislated by Congress, to regulate markets, to carry out all income distribution programs which fit into some political plan. Its members might be inspired public

TABLE 7.4: MARKET SEARCH AND COORDINATION SPECIALISTS

	1967 Employee Compensation ($ Millions)
Information Gatherers	6,132
Enumerators and Interviewers	327
Estimators, Investigators	2470
Inspectors, Exc. Construction, Public	763
Assess, Control, Local Public Admin.	198
Construction Inspector, Public	170
Real Estate Appraisers	205
Insurance Adjusters, Exam.	778
Meter Readers, Utilities	220
Weighers	266
Surveyors	408
Bill Collectors	327
Search and Coordination Specialists	28,252
Buy Side	2,967
Buyers, Shippers, Farm Prod.	146
Buyers, Wholesale, Retail	1185
Purchasing Agents, Buyers	1636
Brokers	7,193
Insurance Agents, Brokers, etc.	3494
Real Estate Agents, Brokers	2219
Stock and Bond Salesmen	1450
Auctioneers	30
Sell Side	18,092
Advertising Agents, Salesmen	598
Sales Representatives, Manufacturing	4092
Sales Representatives, Wholesale Trade	5501
Sales Manager, Retail Trade	2287
Sales Manager, Exec. Retail Trade	3622
Demonstrators	143
Salesmen, Retail (50%)	1313
Salesmen, Service (50%)	536
Planning and Control Workers	58,986
Administrators and managers	53,057
Officials, Administrators, Public	2667
School Administrators, College	475
School Admin., Elementary & Secondary	1801
Office Managers	2363
Other Managers, Administrators	39709
Foremen (50%)	5890
Officer, ship (50%)	152
Process Control Workers	5929
Clerical Supervisors	1600
Postmasters and Mail Superintendents	274
Health Administrators	912
Dispatcher, Starter, Vehicle	432
Expeditors, Production Controllers	1463
Air Traffic controllers	283
Payroll, Time Keeping Clerks	965
TOTAL MARKET SEARCH AND COORDINATION SPECIALISTS	93,370

servants, or they may be fugitives from the "productive sector"--the accounts do not tell. But their job titles imply some organizational or administrative duty which is purely informational in nature: they receive commands from the top of the hierarchy, process them in some routine or creative fashion, and issue commands towards the bottom of the hierarchy. All that passes through their domain are information flows--memos, conferences, decisions, reports--and all that they do during the workday is talk, think, and write. Their counterparts in the private bureaucracies are similarly placed. Operating in a market context, their job is to plan the firm's actions, to design, carry out, and evaluate the firm's movement into marketplaces, to plan and implement technical changes in the firm's production processes, to investigate and analyze their competitors' behavior. They are successful when the firm's market share increases--when the firm is relatively shielded from competitive pressures. The larger and more entrenched the firm, the larger its bureaucracy. In 1967, the administrators and managers earned close to $59 billion dollars, or 7.4% of GNP.

The "process control workers" include seven occupations which are of a coordinating or supervisory nature. Three occupations--dispatchers, expeditors and air traffic controllers--are heavy users of information technology in their daily tasks. A layer of management that is of a purely control nature (e.g., quality, schedule, inventory) will increasingly take on the artifacts of an information economy--computer terminals, distributed information networks, remote sensing instruments and communication hardware.

Information Processors

The information processing occupations are divided into two groups--nonelectronic based and electronic based. Table 7.5 shows a detailed breakdown of the occupations.

"Nonelectronic based" processors include proofreaders, secretaries, file clerks, telegraph messengers, and statistical clerks. Many of these occupations are subject to rapid change with the introduction of new information technologies. For example, the job of proofreading book galleys is now handled by a computer-driven dictionary; file clerks now manage computer files rather than paper files; telegraph messengers are being replaced by inexpensive on-site teletype and facsimile machines. In all, some $34.5 billion was earned by this class of workers in 1967.

"Electronic based" processors include bank tellers, bookkeepers, cashiers, typists, and sales clerks. A significant component of these workers' information handling is already machine based. Tellers operate real-time computers; bookkeepers supply data entry into automated accounting systems; sales clerks operate point-of-purchase terminals. About half of registered nurses' incomes is also allocated to this group. This allocation is made on the basis of observations by a research team at a California hospital of how a nurse allocates time to different activities. A significant portion of the time was spent filling

TABLE 7.5: INFORMATION PROCESSORS

	1967 Employee Compensation ($ Millions)	
Non-Electronic Based*	34,317	
Proofreaders		145
Secretaries, Legal		520
Secretaries, Medical		349
Secretaries, Other		12312
File Clerks		1166
Postal Clerks		2076
Motion Picture Projectionists		113
Newsboys		139
Mail Carriers, Post Office		1829
Mail Handler, Exc. Post Office		632
Messengers and Office Boys		234
Telegraph Messengers		9
Shipping, Receiving Clerks		2481
Statistical Clerks		1651
Health Record Technologist		71
Clerical Asst., Soc Welfare		6
Inspectors, Log and Lumber		93
Inspectors, Other		920
Checkers, Examiners etc.		3957
Receptionists (50%)		789
Miscellaneous Clerical		5953
Railroad Conductors (50%)		32
Electronic Based *	27,023	
Bank Tellers		1201
Billing Clerks		556
Bookkeepers		6896
Cashiers		3347
Typists		4117
Ticket Station, Express Agents		642
Sales Clerks, Retail Trade (50%)		8239
Registered Nurses (50%)		1876
Radiology Technicial (50%)		149
TOTAL INFORMATION PROCESSORS	61.340	

* The last Census Handbook of Occupational Titles describes which occupations are electronic-based. This table reflects the expected changes in classifications based on 1980 technology.

out computer forms, checking computerized log books and entering patient information into a computer file. As hospitals adopt sophisticated information systems, registered nurses will increasingly interact with machines as well as with patients. Whether patients fare better or worse is still a matter of debate within the medical community.

Some occupations have undergone a most remarkable transformation in the past ten years. These machine-based occupations are now the "sensors" of an information creature that is endowed with unlimited processing power, but, without human help, is blind and deaf to the environment. The entire banking system and airline system would be crippled without the constant interaction between machine-using clerks and the computer.

The development of very good real-time sensors allows a host of planning and control activities that were impossible before. As the grocery clerk checks out food by scanning it with a light pen, inventory files are being altered, ordering schedules are being updated, and a financial statement on the day's events is being prepared. This intensity of coordination will require a variety of occupations to become machine based if they are not already so. It is unlikely that typists 20 years from now will still be using stand-alone mechanical typewriters. It costs too much money to type a letter, correct it, transmit it, and file it. Letters will probably be composed on a machine, transmitted, and filed all in one execution--not only business letters, but invoices and receipts. In tandem with a developed funds transfer system, today's typist may be tomorrow's bank clerk, postman, and file clerk, all wrapped up in one.

In 1967, the electronic based information processors earned $27 billion. Together with the nonelectronic based processors, this group accounts for $61.3 billion, or 7.7% of GNP.

Information Machine Workers

The last group of workers maintains and operates the information infrastructure--the computers, telecommunication networks, printing presses, and the like. The occupations displayed in Table 7.6 earned over $13 billion in 1967.

"Nonelectronic machine operators" work on duplicating machines, typesetting machines, and printing presses. Although these machines are currently nonelectronic, the picture may change drastically in the next 20 years. Newsrooms are already automated, from the journalist's input via a terminal through computer-controlled photocomposition, layout, and plate making. The big printing presses are almost the last nonelectronic pieces of a highly electronic production line. Plans for electronic newspapers, delivered via cable lines, will further reduce the requirements for nonelectronic information machine occupations. This reality has already touched off some serious strikes against national newspapers.

"Electronic machine operators" include computer operators, keypunch operators, and office machine repairmen. This category includes the new "blue-collar" component of the information sector--workers who might have worked in factories 50 years ago, but who are now working in air-conditioned office buildings tending to computer-oriented machinery. Their pay, if not their sense of alienation, is commensurately higher.

"Telecommunications workers" operate, repair, and install telephone and telegraph equipment. They support the telecom-

TABLE 7.6: INFORMATION MACHINE WORKERS

	1967 Employee Compensation ($ Millions)
Non-Electronic Machine Operators	4,219
Stenographers	663
Duplicating Machines Operators	92
Other Office Machine Operators	240
Bookbinders	171
Compositors and Typesetters	1138
Electrotypers, Stereotypers	60
Engravers, Exc. Photoengravers	67
Photoengravers, Lithographers	266
Pressmen and Plate Printers	1010
Pressmen Apprentices	19
Printing Apprentices, Exc. Press	31
Photographic Process Workers	379
Sign Painters	83
Electronic Machine Operators	3,660
Bookkeeping, Billing Operators	310
Calculating Machine Operators	162
Computer, Peripheral Equipment Operators	970
Keypunch Operators	1423
Tabulating Machine Operators	48
Data Processing Machine Repair	315
Office Machine Repairmen	432
Telecommunication Workers	5,288
Telegraph Operators	82
Telephone Operators	1738
Telephone Installers, Repairmen	2204
Telephone Linemen, Splicers	375
Radio Operators	190
Radio, Television Repairmen	699
TOTAL INFORMATION MACHINE WORKERS	13,167

munications network at the "assembly" level. Conceptually, this group of workers is indistinguishable from any machine-based blue-collar or crafts occupation. They are accounted separately, however, because without their help the information machines would not be assembled and repaired. By analogy, if one were writing a thesis on "The Transportation Economy," repair mechanics and automobile-assembly workers would surely be included. This group of workers earned some $13 billion in 1967. It is conceivable that demand for mechanical and repair skills of information machines will increase quite quickly in the near future, although the jobs are likely to be redefined as white collar (e.g., "electrical engineer").

THE NONINFORMATION WORKERS

The rest of the U.S. work force was divided into three conventional sectors--agriculture, industry, and services. In 1967, this group accounted for about 55% of the work force and about 45% of total compensation.

The following classification scheme follows in the convention of Clark,[3] who first defined the primary, secondary, and tertiary sectors of the economy as stages of economic growth.

Agriculture

The agriculture sector includes farm owners, managers, foremen, and laborers. Some owners and managers may be information workers, but they were included in the agriculture sector. Farmers actually spend a great deal of their time in a variety of informational activities. The morning weather reports and commodity exchange prices are ritual sources of information gathering. Farmers also spend considerable time with information "pushers" such as salesmen for seed and fertilizer companies (who often supply very detailed data on how to apply and use their products), and government advisers (such as the Agricultural Extension Service). In addition, the agriculture sector hires information workers who are specialized in the various skills necessary to run a modern agribusiness--salesmen, accountants, lawyers, secretaries, and the like. This last group is not included as agriculture workers per se, but will be accounted later in this chapter.

Industry

Industrial workers include the bulk of blue-collar manufacturing occupations, skilled and unskilled crafts, operatives, and laborers. A variety of service-type jobs are included in industry, such as plumbers and glazers, since these occupations engage in manipulating physical objects rather than providing personal or informational services. The industry category conceptually includes all skilled crafts whether they are based in factories or not.

Several transportation occupations have been included in this sector. For example, railroad brakemen and truck drivers are in the transportation sector, hence included as a "service." But transportation of bulk commodities is an essential feature of an industrial economy, as distinct from the transportation of people. Taxicab drivers and bus drivers have been defined as part of the service sector; truck drivers and barge captains are part of industry.

Services

The service sector includes mostly personal and repair-service occupations, such as hairdressers, waiters, airplane pilots, auto repairmen, and counter clerks. In addition, half the wages of selected managers is included as services rather than information. Managers at the retail level, whether self-employed or salaried, perform both informational and noninformational roles depending on the type of business. For example, managers of gas stations usually perform the same duties as mechanics and station attendants--repairing automobiles, pumping gas--and are classified in "services." Managers of retail grocery stores may stock shelves and bag food for customers--noninformational activities--or they may specialize in purchasing, financial control, and personnel types of activities. This distinction depends entirely on the size of the establishment, the preferences of the manager, and the legal form of organization. One might expect salaried managers to be more like information workers than small "ma and pa" retail proprietorships. Salesmen at the retail and service level also perform both an informational service and a personal service. For example, a salesman at a clothing store might be there only to counsel a customer as to the price and quality features of a garment and to ring up a sale, or he may actually help the customer try on garments. Many salesclerks only operate information machines--credit verification and point-of-purchase terminals. Without a detailed time budget study, it is impossible to determine which portion of a salesman's time is informational, and which should be allocated to service. Half the income was allocated to each.

Physicians' incomes were also prorated equally between services and information, following the discussion in Chapter 3 on a time budget of physicians' offices. Time budget studies of physicians' offices revealed that over 70% of a physician's time is spent in receiving patient histories, performing diagnoses, and dispensing medical or self-care patient education--all information tasks. A relatively small part of the time is spent in the skilled-craft aspect, such as office surgery, cleaning wounds, and setting broken bones. Dentists, by contrast, were entirely allocated to services since most of their time is spent in the skilled-craft aspect attending to a personal service.

Summary of Ambiguous Occupations

About 28 occupations were judged to be sufficiently "mixed" in nature that they were allocated into two sectors. This ambiguous class was specifically carried through the time-series charts that follow.

Table 7.7 shows the occupations which were split equally between information and services under the "inclusive" definition, and allocated entirely to services under the "restrictive" definition.

TABLE 7.7: OCCUPATIONS ALLOCATED 50% TO SERVICE AND 50% TO INFORMATION

Physicians
Registered Nurses
Dietitians
Clinical Lab Technologists
Health Record Technologists
Radiological Technologists
Designers
Counter Clerks, exc. food
Officers, Pilots, Pursers on Ships
Officials of Lodges, Societies, Unions
Railroad Conductors
Demonstrators
Hucksters
Sales Clerks, Retail Trades
Misc. Clerical Workers
Managers, Retail Trade, Salary
Managers, Retail Trade, Self-Emp.
Managers, Personal Services, Salaried
Managers, Personal Services, Self-Employed
Managers, Business Services, Salaried
Managers, Business and Repair Services, Self-Employed
Receptionists

Table 7.8 shows the occupations that were split equally between industry and information under the inclusive definition, and allocated entirely to industry under the restrictive definition.

Foremen used to work on machines alongside craftsmen. However, with the advent of unions, foremen were increasingly relegated to nonproduction jobs such as scheduling, inventory control, and on-the-job training. They are now a "buffer" between the productive workers and the managers, and are often specifically barred from working on machines for fear of breaking union rules. Similarly, inspectors, checkers, and the like often work in industrial settings but most of their time is spent gathering information about a production process.

TABLE 7.8: OCCUPATIONS ALLOCATED 50% TO INDUSTRY AND 50% TO INFORMATION

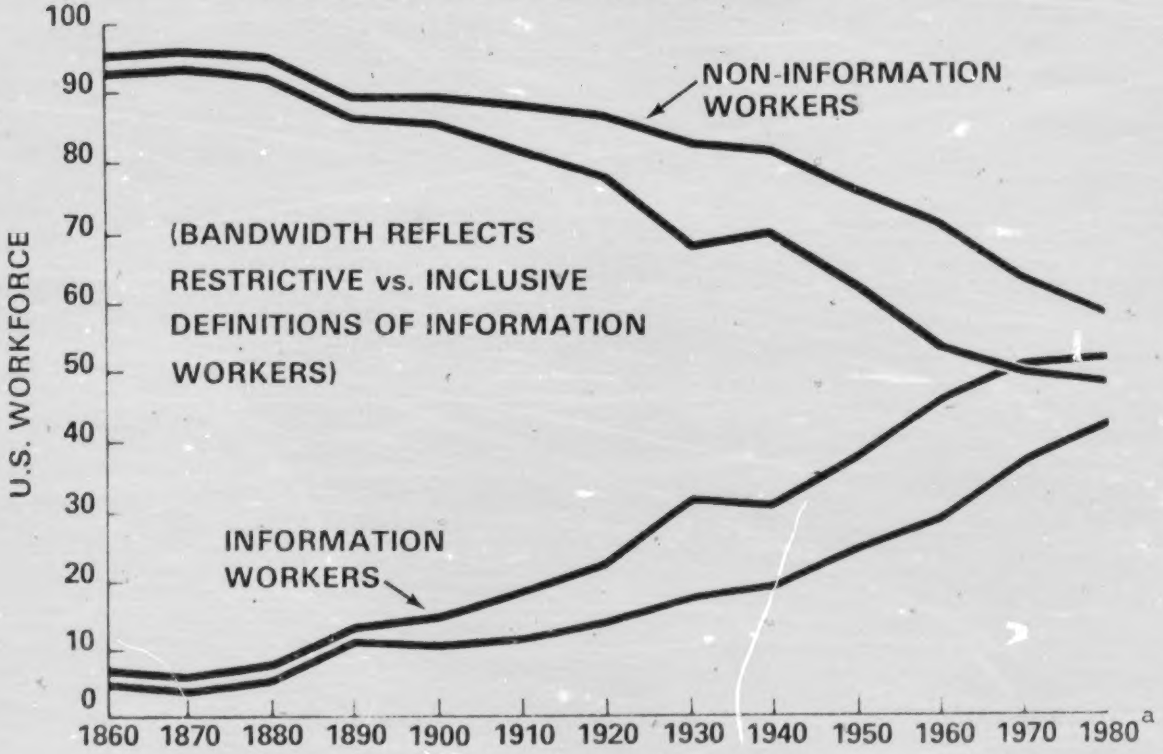
Foreman, NEC
Inspectors, Scalers, Graders, Lumber
Inspectors, NEC
Chainmen, Rodmen (Surveying)
Checkers, Examiners, Inspectors (Manufacturing)
Graders and Sorters (Manufacturing)

Change in the Work Force over Time

The change in the labor force towards a predominance of information workers has been persistent since the 1940's. Figure 7.1 shows a two-sector aggregation, using the restrictive and inclusive definitions discussed above. The information work force in 1860 comprised less than 10% of the total. By 1975, the information workers (under the inclusive definition) surpassed the noninformation group. The crossover in employee compensation occurred much sooner, since information occupations tend to earn a higher average income. By 1967, some 53% of total compensation was paid to information workers.

FIGURE 7.1:

TIME SERIES OF U.S. LABOR FORCE (1860 — 1980) TWO SECTOR AGGREGATE BY PERCENT



[a] 1980 projections supplied by the Bureau of Labor Statistics (unpublished).

FIGURE 7.2:

FOUR SECTOR AGGREGATION OF THE U.S. WORK FORCE BY PERCENT
1860 - 1980

(Using median estimates of information workers)

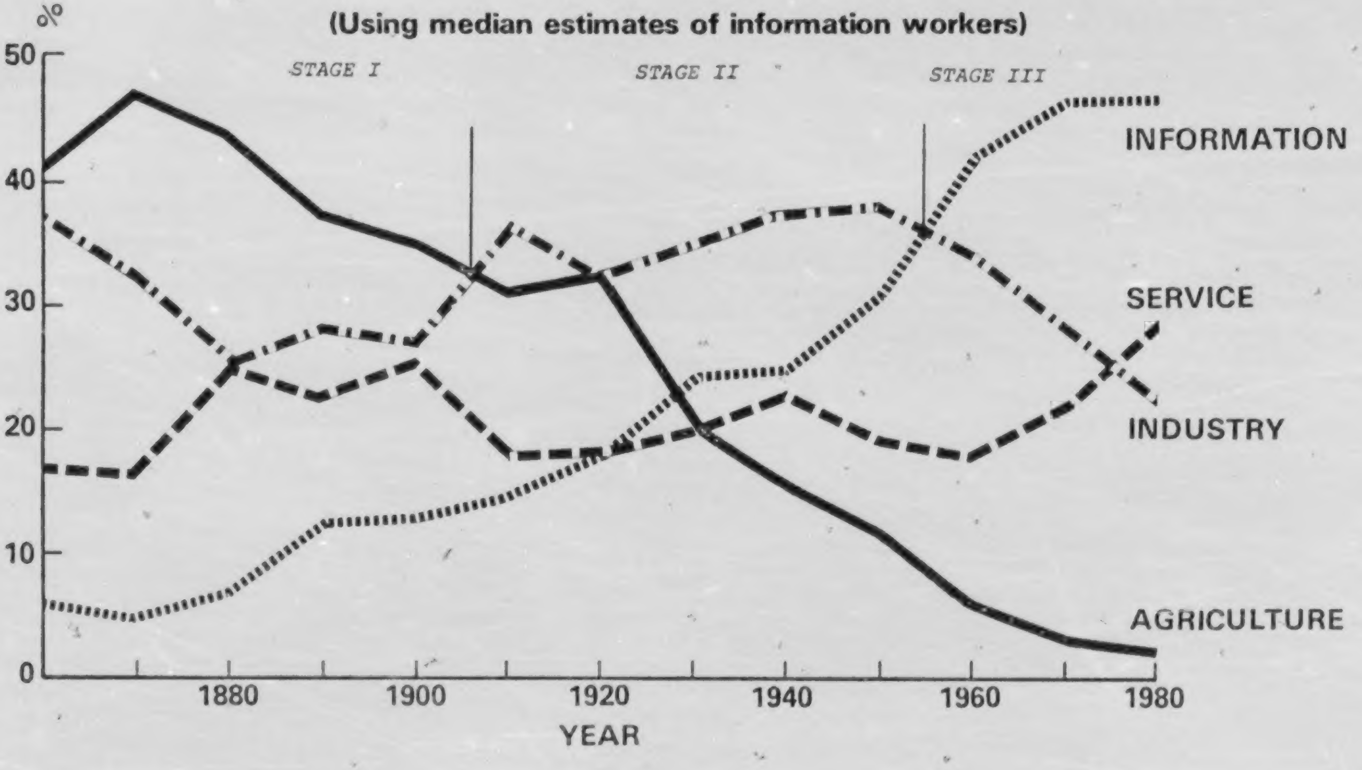


Figure 7.2 displays the same data in a four-sector aggregation. The charts clearly reveal the transformation of the United States through three distinct stages.

In Stage I (1860-1906), the largest single group in the labor force was agriculture. By the turn of the century, industrial occupations began to grow rapidly and became predominant during Stage II (1906-1954). In the current period, Stage III, information occupations comprise the largest group.

The charts also reveal several events worthy of further research. The detailed data in Appendix 7 (Vol. 8) show a decline in information occupations' growth during the Depression, attributable to layoffs of nonessential personnel. (See Figure 7.3.) A hypothesis emerges: that layoffs in information occupations lag recessions by one or two years. Since the output of an information worker is not easily measurable, and since informational skills generalize more easily than physical skills, the group as a whole seems quite vulnerable to layoffs. When a factory is faced with declining demand for its goods, the rate of production slowdown precisely determines how many production workers lose their jobs. Machines and manpower are locked by virtue of fixed capital/labor ratios. Hence, a reduction in machine utilization determines a proportionate reduction in labor. To a certain extent, even this reduction of production workers can be cushioned by inventory accumulation. By contrast, information workers are not locked into capacity utilization. They can be hired and fired at a rate that is relatively decoupled from the production line. The managerial "slack"--such as extra secretaries, a heavy line of middle management, and a large sales force--can be trimmed quite quickly.

Note also the rapid rise of information occupations immediately following World War II. As the soldiers came home, they apparently joined the private and public bureaucracies in droves. They did not return to manufacturing jobs or service work (as was the trend immediately before the war). This postwar period is associated with the emergence of the modern corporation: far-flung, national or multinational in scope, bureaucratic. And it is also associated with the development of new information machines--computers, xerographic copiers, telecommunication networks.

New information applications were found, and the labor force adjusted to fill the new demand. In part, the rapid growth of information occupations is explained by increased division of labor and specialization. Simple one-person information tasks split into two jobs. Information machines required highly specialized labor. Job titles and duties became narrower. However, calling a job by a different name does not change the basic function. Governments expanded very rapidly at the State and local level (less so at the Federal level), and these, too, required a huge information work force. Science and technology enjoyed a sizable growth in activity, both within the university and within private industry. The education system concurrently began receiving massive Federal grants and transfers, further increasing both the demand for teachers and the supply of information workers (managers, scientists, engineers, computer programmers).

Note also that the industrial work force reached a peak of around 40% of the work force in 1950, and has been declining precipitously since then. It plunged from a position of predominance in 1940, when the information work force was less than half the size of the industrial work force, to the present, with the industrial work force only half the size of the information work force. This reversal was extremely rapid, and from all indications the trend has only recently been abated.

Note lastly that service occupations, which held a steady 15-20% of the work force for 100 years (1860-1960) suddenly took off again in 1965. This is due to two phenomena. First, I believe that we have temporarily saturated the work force with information workers--no more can be easily absorbed into industry and government. Hence, the growth of new occupations is mostly in the personal services. The second phenomenon is the increase in the medical professions, such as physicians, surgeons, nurses, medical technologists, and therapists. Part of this increase is due to the demand for new medical services, buoyed by rising expectations, rising income, and financed by insurance programs which stack the incentives in favor of surgery and hospitalization instead of preventative care. Partly, the rise in medical occupations has reflected the fact that people are living longer and requiring more medical attention. The growth rate of the service occupations is now almost equal to that of information workers.

INFORMATION WORKERS IN INDUSTRY AND GOVERNMENT

The previous sections discussed only one dimension of the U.S. work force--who the workers are and how much they receive in employee compensation. In this section, we shall look at the second dimension--where they work.

The following results are based on the Occupation by Industry matrix, prepared by the Bureau of the Census and the Bureau of Labor Statistics. The matrix shows the location of the 422 occupations in 201 major industries. We converted the matrix to show the employee compensation paid to each type of worker in each industry. The detailed 1967 wage matrix, with a description of the data sources and methodology, is presented in Appendix 7 (Vol. 6).

Information Workers in Industry

Table 7.9 shows the labor income earned in the primary information industries. Wages paid to information workers hired by private corporations amounted to $69 billion. In addition, the information industries spent $26 billion on noninformation workers (e.g., assemblers in a computer manufacturing firm). Proprietors working as information workers, in pure management roles, earned $7 billion in 1967. An additional $2 billion was earned by "blue-collar" partnerships in the primary information sector (e.g., self-employed TV repairmen). "Unpaid family workers" are spouses and children who are assigned a salary if they perform informational types of jobs (e.g., bookkeeper or typist). In all, the primary information industries accounted for nearly $29 billion in labor income in 1967.

TABLE 7.9: LABOR INCOME IN THE PRIMARY INFORMATION INDUSTRIES

($ Millions, 1967)

PRIMARY INFO INDUSTRY	EMPLOYEE COMPENSATION	PROPRIETOR'S COMPENSATION	UNPAID FAMILY COMPENSATION	TOTAL INCOME
INFORMATION WORKERS				
11* Info buildings: office,education,comm	1232	222	10	1464
12* Maintenance & repair on info buildings	1280	230	10	1520
23* Office furniture & equipment	117	8	1	126
24* Paper: printing (exc boxes)	403	2	0	405
26* Printing & publishing	6340	304	44	6688
27* Ink	36	0	0	36
48* Printing & paper machinery	153	4	0	157
51* Computers, calculators, office equip.	1517	7	1	1525
53* Electronic measuring instruments	267	2	0	269
56* Radio, TV, comm'n equipment	4131	11	1	4143
57* Electronic components	1651	13	1	1665
58* Misc electronic instruments	40	0	0	40
62* Mechanical measuring & control instruments	842	7	1	850
63* Photographic & related equipment	765	8	1	774
64* Advertising signs & displays	226	19	1	246
66* Telecommunications, exc. radio & TV	6091	10	2	6103
67* Radio, TV, CATV	939	23	5	967
69* Trade margin on info goods	5576	1169	117	6862
70* Finance & insurance: components	18505	1144	48	19697
71* Real estate: fees, royalties, office rentals	341	225	9	575
72* Repair: radio & TV equipment	141	123	11	275
73* Misc business info services	10114	2320	88	12522
76* Motion pictures	842	125	8	975
77* Medical, educational, nonprofit	7401	553	49	8003
TOTAL INCOME OF INFO WORKERS	68950	6529	408	75887
NON-INFORMATION WORKERS				
11* Info buildings: office,education,comm	2487	358	7	2852
12* Maintenance & repair on info buildings	2584	372	8	2964
23* Office furniture & equipment	247	5	0	252
24* Paper: printing (exc boxes)	595	1	0	596
26* Printing & publishing	1267	18	5	1290
27* Ink	34	0	0	34
48* Printing & paper machinery	174	3	0	177
51* Computers, calculators, office equip.	483	2	0	485
53* Electronic measuring instruments	237	0	0	237
56* Radio, TV, comm'n equipment	2183	4	1	2188
57* Electronic components	1468	3	1	1472
58* Misc electronic instruments	36	0	0	36
62* Mechanical measuring & control instruments	550	2	0	552
63* Photographic & related equipment	515	3	0	518
64* Advertising signs & displays	261	11	1	273
66* Telecommunications, exc. radio & TV	407	2	0	409
67* Radio, TV, CATV	121	3	0	124
69* Trade margin on info goods	3925	437	62	4424
70* Finance & insurance: components	483	12	1	496
71* Real estate: fees, royalties, office rentals	12	28	4	44
72* Repair: radio & TV equipment	351	93	9	453
73* Misc business info services	2566	387	11	2964
76* Motion pictures	624	110	2	736
77* Medical, educational, nonprofit	4820	259	25	5104
TOTAL INCOME OF NON-INFO WORKERS	26430	2113	137	28955

Table 7.10 shows the wage bill for information workers employed in the bureaucracies of noninformation firms; and partners who are essentially specialized in informational duties but are located in noninformation enterprises. Together with Table 7.11, which shows the noninformation workers in noninformation firms, the entire wage bill is fully apportioned.

The last two tables show the intensity of information resources used in each industry. For example, the ratio of information to noninformation labor in the livestock industry (#1) is 1:128, whereas in the ordnance industry (#13) the ratio runs nearly 2:1 in the opposite direction. For all industries, every production worker on average carries an information "overhead" of about 74 cents per dollar earned.

Definition of Proprietors' Income

One methodological note on the meaning of labor income is in order. Employee compensation totalled $471,090 million in 1967 and included wages, salaries, and supplements paid to employees of firms (incorporated and unincorporated), plus governments and nonprofit organizations. All proprietors' income is usually not counted as employee compensation, but appears as a property-type income. Proprietorships' income is in the form of retained earnings of unincorporated businesses, and represents a return to both capital (invested in the business and owned by the proprietor) and labor. The problem is how to separate the returns to labor from returns to capital, and three approaches are available: (i) Denison[4] defined labor earnings in the economy as the sum of employee compensation plus 60% of proprietors' income, the other 40% representing returns to capital holding. (ii) The National Income Accounts define all of proprietors' income as profit or property-type income. (iii) Jorgenson and Griliches[5] chose the opposite tack--that all of proprietors' income should be allocated to labor.

We adopted a method to test these three approaches. Proprietors are allocated an average wage (as if they were salaried) based on empirical observation of similar occupations. The distinction between a proprietor and a salaried worker hinges entirely on the firm's legal form of organization--if a proprietor incorporated the business, his earnings would be accounted as a salary. The difference between the "wages" earned by proprietors and total proprietors' income is counted as returns to capital. In this procedure, all unpaid family workers are assigned "wages" based on what they would earn if they were in fact salaried. Using this empirical approach, we discovered

TABLE 7.10: LABOR INCOME IN THE SECONDARY INFORMATION INDUSTRIES

($ Millions, 1967)

IO INDUSTRY	EMPLOYEE COMPENSATION	PROPRIETOR'S COMPENSATION	UNPAID FAMILY COMPENSATION	TOTAL INCOME
1) Livestock & products	24	10	4	38
2) Other agricultural products	43	17	7	67
3) Forestry and fishery products	23	25	6	54
4) Agr., Forest, Fish Services	166	88	32	286
5) Iron & ferroalloy ores mining	69	2	0	71
6) Nonferrous metal ores mining	116	3	0	119
7) Coal mining	179	9	1	189
8) Crude petroleum and natural gas	481	94	6	581
9) Stone & clay mining & quarrying	217	14	2	233
10) Chemical & fertilizer mineral min.	55	4	1	60
11) New construction, Net	7084	1273	55	8412
12) Maintenance & repair construction	2618	471	20	3109
13) Ordnance and accessories	2651	3	0	2654
14) Food & kindred products	4569	101	15	4685
15) Tobacco manufactures	247	1	0	248
16) Fabrics, yarn & thread mills	1016	17	1	1034
17) Misc. textile goods & floor cover.	312	5	0	317
18) Apparel	2182	71	6	2259
19) Misc. fabricated textile products	345	26	2	373
20) Lumber, wood prod. exc. containers	826	168	4	998
21) Wooden containers	50	5	0	55
22) Household furniture	538	36	2	576
23) Other furniture, fixtures, Net	180	12	1	193
24) Paper,allied prod. exc containers, Net	1145	6	1	1152
25) Paperboard containers, boxes	726	7	0	733
26) Printing & publishing, Net	514	25	4	543
27) Chemicals, sel Chem products, Net	2213	11	1	2225
28) Plastics, synthetic materials	855	4	0	859
29) Drugs, cleaning, toilet preparations	1579	14	3	1596
30) Paints & allied products	380	4	2	386
31) Petroleum refining & related ind's.	1274	5	0	1279
32) Rubber & misc plastics products	1651	21	3	1675
33) Leather tanning, ind. leather prods.	60	2	0	62
34) Footwear & other leather products	436	15	1	452
35) Glass & glass products	554	10	1	565
36) Stone & clay products	1345	61	5	1411
37) Primary iron & steel manufacturing	2842	14	1	2857
38) Primary nonferrous metal manufacturing	1312	12	1	1325
39) Metal containers	315	6	0	321
40) Heating, plumbing & struc metal prods.	1475	50	4	1529
41) Stamping,screw mach. prods & bolts	1183	13	1	1197
42) Other fabricated metal products	1535	28	2	1565
43) Engines and turbines	467	1	0	468
44) Farm machinery & equipment	550	6	1	557
45) Const., mining & oil field machs.	823	7	0	830
46) Materials handling mach & equipment	376	3	0	379
47) Metalworking mach & equipment	1436	43	3	1482
48) Spec ind mach & equipment, Net	733	21	1	755
49) General ind mach & equipment	1203	35	2	1240
50) Machine shop products	766	22	2	790
52) Service industry machines	539	16	1	556
53) Elec ind equip & apparatus, Net	1497	12	1	1510
54) Household appliances	540	7	1	548
55) Electric lighting & wiring equip.	635	5	0	640
58) Misc elec machinery, Net	478	4	0	482
59) Motor vehicles & equipment	2969	17	3	2989
60) Aircraft and parts	5077	11	1	5089
61) Other transportation equipment	887	26	2	915
62) Scientific and controlling instru.	267	8	1	276
63) Optical,ophthalmic&photo equip, Net	70	3	0	73
64) Misc manufacturing, Net	1035	85	6	1126
65) Transportation & warehousing	7272	460	62	7794
68) Electric,gas,water & sanitary svcs	2467	30	4	2501
69) Wholesale & retail trade, Net	32279	8673	915	41867
70) Finance & insurance, Net	469	71	2	542
71) Real estate & rental, Net	1474	970	41	2485
72) Hotels:personal&rep svcs exc auto,Net	1779	1728	154	3661
73) Business services, Net	2837	3503	33	6373
75) Automobile repair & services	1072	257	31	1360
76) Amusements, Net	504	206	14	724
77) Medical,educ svcs&non-profit org, Net	4331	2265	53	6649
85) Rest of the world industry	32	0	0	32
86) Household industry	421	64	1	486
TOTAL INCOME	120,670	21,322	1,526	143,518

TABLE 7.11: LABOR INCOME IN THE NON-INFORMATION INDUSTRIES

($ Millions, 1967)

INDUSTRY	EMPLOYEE COMPENSATION	PROPRIETOR'S COMPENSATION	UNPAID FAMILY COMPENSATION	TOTAL INCOME
1) Livestock & products	1187	3332	336	4855
2) Other agricultural products	2126	5967	602	8695
3) Forestry and fishery products	89	101	11	201
4) Agr., Forest, Fish Services	552	704	56	1312
5) Iron & ferroalloy ores mining	183	1	0	184
6) Nonferrous metal ores mining	307	2	0	309
7) Coal mining	1058	8	1	1067
8) Crude petroleum and natural gas	401	30	2	433
9) Stone & clay mining & quarrying	516	9	1	526
10) Chemical & fertilizer mineral min.	131	2	0	133
11) New construction, Net	14293	2060	42	16395
12) Maintenance & repair construction	5281	761	16	6058
13) Ordnance and accessories	1446	2	0	1448
14) Food & kindred products	8613	72	15	8700
15) Tobacco manufactures	356	1	0	357
16) Fabrics, yarn & thread mills	2369	8	2	2379
17) Misc. textile goods & floor cover.	480	2	0	482
18) Apparel	4624	16	4	4644
19) Misc. fabricated textile products	557	13	2	572
20) Lumber, wood prod. exc. containers	2258	223	12	2493
21) Wooden containers	103	3	0	106
22) Household furniture	1136	22	2	1160
23) Other furniture, fixtures, Net	381	7	1	389
24) Paper,allied prod. exc containers, Net	1688	4	1	1693
25) Paperboard containers, boxes	951	2	1	954
26) Printing & publishing, Net	103	1	0	104
27) Chemicals, sel Chem products, Net	1977	3	1	1981
28) Plastics, synthetic materials	1131	1	0	1132
29) Drugs, cleaning, toilet preparations	882	2	1	885
30) Paints & allied products	263	1	0	264
31) Petroleum refining & related ind's.	992	3	0	995
32) Rubber & misc plastics products	2355	7	3	2365
33) Leather tanning, ind. leather prods.	174	1	0	175
34) Footwear & other leather products	1043	5	1	1049
35) Glass & glass products	860	5	1	866
36) Stone & clay products	2036	21	3	2060
37) Primary iron & steel manufacturing	6334	12	1	6347
38) Primary nonferrous metal manufacturing	2141	6	0	2147
39) Metal containers	438	3	0	441
40) Heating, plumbing & struc metal prods.	1961	22	1	1984
41) Stamping,screw mach. prods & bolts	1896	4	1	1901
42) Other fabricated metal products	2091	12	1	2104
43) Engines and turbines	537	1	1	539
44) Farm machinery & equipment	699	2	0	701
45) Const., mining & oil field machs.	904	3	0	907
46) Materials handling mach & equipment	413	2	0	415
47) Metalworking mach & equipment	1855	24	1	1880
48) Spec ind mach & equipment, Net	832	15	1	848
49) General ind mach & equipment	1367	24	1	1392
50) Machine shop products	870	16	1	887
52) Service industry machines	612	11	0	623
53) Elec ind equip & apparatus, Net	1331	3	1	1335
54) Household appliances	805	2	1	808
55) Electric lighting & wiring equip.	565	1	0	566
58) Misc elec machinery, Net	425	1	0	426
59) Motor vehicles & equipment	5484	14	3	5501
60) Aircraft and parts	3498	8	0	3506
61) Other transportation equipment	1603	21	2	1626
62) Scientific and controlling instru.	300	5	0	305
63) Optical,ophthalmic&photo equip, Net	69	1	0	70
64) Misc manufacturing, Net	1197	49	3	1249
65) Transportation & warehousing	13657	901	44	14602
68) Electric,gas,water & sanitary svcs	2437	46	3	2486
69) Wholesale & retail trade, Net	28032	3696	541	32269
70) Finance & insurance, Net	12	0	0	12
71) Real estate & rental, Net	53	122	17	192
72) Hotels:personal&rep svcs exc auto,Net	4804	2996	96	7896
73) Business services, Net	519	37	2	558
75) Automobile repair & services	2713	801	24	3538
76) Amusements, Net	905	64	7	976
77) Medical,educ svcs&non-profit org, Net	6985	4297	15	11327
85) Rest of the world industry	13	0	0	13
86) Household industry	4280	38	4	4322
TOTAL INCOME	165,539	26,662	1,919	194,120

that about $60.6 billion was earned as "wages" by proprietors and unpaid family workers, while about $2 billion represents a return to capital. These figures are summarized in Table 7.12 below.

TABLE 7.12: SUMMARY OF PROPRIETORS' INCOME

	1967 ($ Millions)	
TOTAL PROPRIETORS' INCOME (labor & capital)	62,147	
"Compensation" to proprietors' labor	56,626	
In primary information industries		8,642
In secondary information industries		21,322
In non-information industries		26,662
Proprietors' comp/total income		91.1%
"Compensation" to unpaid family workers	3,990	
In primary information industries		545
In secondary information industries		1,526
In non-information industries		1,919
Unpaid family/total income		6.41%
Imputed return on capital	1,531	
Capital/total income		2.6%
Capital/income (exc. unpaid family)		8.9%

The share of proprietors' income earned as wages (on a par with salaried managers) amounted to some 91% of total income. If we supplement that income with par wages earned by their unpaid family workers, the total share of income attributed to labor rises to 97%. Using the proprietors' "compensation" only (and excluding unpaid family), we see that around 8.9% of total income represents a return to capital.

The 8.9%, as an imputed return to capital, compares with the corporate sector's capital share of 17.4% shown in Table 7.13. Proprietors earn less "profits" on average than do corporations. This statistic probably confounds the capital shares experienced in the two sectors since partnerships are significantly smaller than most active corporations. The difference between the 8.9% and the 17.4% could be explained by dividing the sample into similar firms (in revenue terms), and comparing the capital share in each. Also, proprietorships tend to be found in businesses which are not capital intensive, such as retail and service establishments, hence their portion of total income accruing from capital ownership is likely to be smaller than the average corporation.

We conclude from these data that the Jorgenson and Griliches approach--allocating proprietors' income to labor--is more correct than either Denison's or the NIA's approach.

TABLE 7.13: LABOR AND CAPITAL SHARES IN THE CORPORATE SECTOR

	1967 ($ Millions)	
TOTAL CORPORATE INCOME (labor & capital)	451,221	
Compensation to employees	372,535	
Wages and salaries (private)		337,322
Supplements		35,213
Corporate profits and inventory valuation adjustment	78,686	
Profits before taxes		79,815
Inventory valuation adjustments		- 1,129
Capital income/total income		17.4%
Labor income/total income		82.6%

Information Workers in Government

Governments, by habit and tradition, tend to spawn into permanent bureaucracies. The Federal, State and local governments are filled with administrators and clerks whose job is to know, to deliberate and to decide.

All this thinking, talking and writing requires human labor, and Table 7.14 shows the price tag paid for all government workers. Some things that governments do are also done in the primary information sector. For example, data processing shops are found both inside government and in the private economy. Other things that governments do are of a general management nature. Chapter 8, to follow, outlines these secondary activities in detail.

Table 7.14 reveals that around $59 billion--or 7.5% of GNP in 1967--is generated by the primary and secondary informational activities of Federal, State and local governments and their enterprises. Of this sum, nearly $27 billion is paid by State and local governments for education workers; $9 billion pays for the Federal information bureaucracy; $8 billion pays for the purely informational portion of the military establishment; and slightly more than $1 billion pays for moving the U.S. mail. Note that the Federal bureaucracy is less than half the size of the state and local bureaucracies. It has the cosmetic disadvantage, however, of being concentrated in a 9 square mile area on the banks of the Potomac.

The noninformational aspects of government, activities such as protecting bald eagles and polishing brass on nuclear submarines, account for $30 billion. The combined wage bill for all blue-collar workers in State and local enterprises is less than $11 billion.

TABLE 7.14: EMPLOYEE COMPENSATION IN GOVERNMENTS[a]

($ Millions, 1967)

	PRIMARY INFO ACTIVITIES	SECONDARY INFO ACTIVITIES	TOTAL INFO ACTIVITIES	NON-INFO ACTIVITIES	TOTAL LABOR INCOME
ALL GOVERNMENTS	40,699	18,735	59,434	30,073	89,507
Total General Government	37,160	15,958	53,118	28,536	81,654
Total Federal Government	10,232	6,357	16,589	18,616	35,205
Civilian	5,800	3,009	8,809	7,554	16,363
Military	4,432	3,348	7,780	11,062	18,842
Total State and Local	26,928	9,601	36,529	9,920	46,449
Education	26,928	0	26,928	0	26,928
Other	0	9,601	9,601	9,920	19,521
Total Enterprises	3,539	2,777	6,316	1,537	7,853
Total Federal Enterprises	3,539	1,336	4,875	908	5,783
Postal Service	3,539	0	3,539	0	3,539
Other	0	1,336	1,336	908	2,244
Total State & Local Enterprises	0	1,441	1,441	629	2,070

---

[a] The definitions of "primary" and "secondary" information activities of governments are given in Chapter 8.

Labor Income Summary

The information wage bill in 1967 amounted to $307.5 billion--$145 billion for all primary information activities, and $162 billion for the secondary activities. About 58% of all labor income--or 38.7% of the 1967 GNP--was earned in some informationally related occupation.

These figures are summarized in Table 7.15.

GROWTH RATES OF THE INFORMATION WORK FORCE

The information work force expanded at a compound (annual) rate of 3.85% during the period 1860-1980, doubling every 18.7 years on the average. During the same period, the total work force increased at 2.06% per year; hence, information workers experienced a net annual average growth of 1.79%.

This astonishing growth rate was far from monotonic, as Table 7.16 and Figure 7.3 clearly show. The growth of the information work force (r^i) is compared to the growth of the whole work force $(\bar{r})$,

$$r^i - \bar{r} = \left(\frac{t_1^i}{t_2^i}\right)^{\frac{1}{n}} - \left(\frac{\bar{t}_1}{\bar{t}_2}\right)^{\frac{1}{n}}$$

where, t_1^i, $\bar{t}_1$ = the size of the information and the whole workforce at time 1.

t_2^i, $\bar{t}_2$ = the same at time 2.

n = time period between the measurements.

In the most recent period, the information workers expanded at almost the same rate as the overall work force (net rates of 1.01% for 1960-1970, and 0.04% projected for 1970-1980). New entrants to the labor force simply could not be absorbed into information occupations, and had to move into the service sector, including a large contingency into the medical service sector.

The decade immediately following World War II showed the fastest net growth rates of information occupations, posting 2.2% between 1940-1950, and 3.2% between 1950-1960. This confirms the trend in both the public and the private sectors towards increased bureaucratization. New information machines and management techniques were introduced around this time, and the work force rapidly expanded to fill the need.

The Depression years, extending into the mid 1930's, saw a slow down in the growth of information jobs. While the total work force increased at a snail's pace of 0.48% per year, information occupations grew only 0.64%--a net difference of only 0.16%. Unfortunately, the census data do not appear at more frequent intervals so we lose the trend in the late 30's.

TABLE 7.15: LABOR INCOME SUMMARY

($ Millions, 1967)

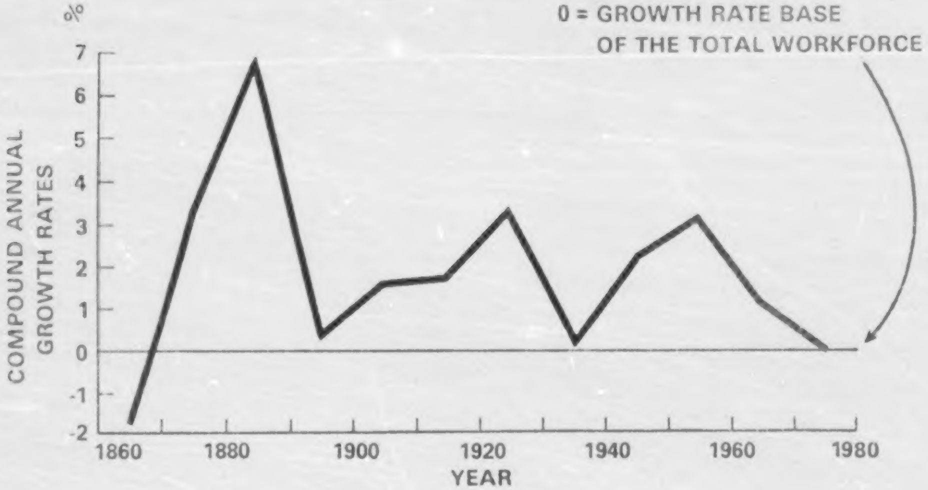
	(1) PRIMARY INFO INDUSTRIES	(2) SECONDARY INFO INDUSTRIES	(1+2) TOTAL INFO INDUSTRIES	(3) NON-INFO INDUSTRIES	(1+2+3) TOTAL LABOR INCOME
I. TOTAL LABOR INCOME	145,266	162,253	307,519	224,187	531,706
Employee Compensation	136,079	139,405	275,484	195,606	471,090
Private Sector	95,380	120,670	216,050	165,533	381,583
Public Sector	40,699	18,735	59,434	30,073	89,507
Proprietors' Income[a]	9,187	22,848	32,035	28,581	60,616
II. INFORMATION WORKERS' INCOME	116,311	162,253	278,564	0	278,564
Employee Compensation	109,374	139,405	248,779	0	248,779
Private Sector	68,950	120,670	189,620	0	189,620
Public Sector	40,424	18,735	59,159	0	59,159
Proprietors' Income[a]	6,937	22,848	29,785	0	29,785
III. NON-INFORMATION WORKERS' INCOME	28,955	0	28,955	224,187	253,142
Employee Compensation	26,705	0	26,705	195,606	222,311
Private Sector	26,430	0	26,430	165.533	191,963
Public Sector	275	0	275	30,073	30,348
Proprietors' Income[a]	2,250	0	2,250	28,581	30,831

[a] Includes self-employed and unpaid family.

FIGURE 7.3:

NET GROWTH RATES OF INFORMATION OCCUPATIONS

(RELATIVE TO THE OVERALL WORKFORCE)



0 = GROWTH RATE BASE OF THE TOTAL WORKFORCE

TABLE 7.16: COMPOUND ANNUAL GROWTH RATES OF THE LABOR FORCE

(BY PERCENTS)

PERIOD	INFORMATION WORKERS	TOTAL LABOR FORCE	NET INFORMATION GROWTH [a]
TEN-YEAR PERIODS			
1860 - 1870	2.26	4.21	-1.95
1870 - 1880	6.53	3.35	3.18
1880 - 1890	9.57	2.72	6.85
1890 - 1900	2.84	2.51	0.33
1900 - 1910	4.74	3.16	1.58
1910 - 1920	3.06	1.30	1.76
1920 - 1930	4.55	1.21	3.34
1930 - 1940	0.64	0.48	0.16
1940 - 1950	2.94	0.77	2.17
1950 - 1960	4.80	1.60	3.20
1960 - 1970	2.69	1.68	1.01
1970 - 1980	1.85	1.81	0.04
TWENTY-YEAR PERIODS			
1940 - 1960	3.87	1.18	2.69
1960 - 1980	2.27	1.74	0.53
FORTY-YEAR PERIODS			
1860 - 1980	3.85	2.06	1.79
1860 - 1900	5.26	3.20	2.06
1900 - 1940	3.24	1.53	1.71
1940 - 1980	3.07	1.46	1.61

[a] Growth rate of information workers minus the growth rate of the total labor force.

The first 30 years of this century are associated with the industrial age; however, information workers consistently expanded faster than the overall labor force, increasing in net terms at over 3% between 1920 and 1930 alone. This growth corresponds to the "secondary information sector"--information services performed within noninformation firms--and will be discussed in Chapter 9. At no point have the information occupations lagged behind the overall work force, although the net rates dip twice to the zero line (between 1930-1940, and between 1970-1980). The data in Table 7.16 show extremely rapid growth rates between 1870 and 1890. In part, the growth is a definitional artifact: as family farms and businesses dissolved in the face of industrialization and urbanization, jobs assumed a formality that was measured by the Census. The son and daughter vanished, and an employee took their place. Also, this period marked the beginning of the national corporations. The railroads, the marketing chains, the steel firms set up national headquarters in New York and Chicago, and established the first fledgling private bureaucracies.

It remains to be seen whether the information work force increases at the pace of the 40's and 50's ever again. I rather doubt it. Resurgence in the information occupations is likely only if new types of information industries are launched by entrepreneurs--information utilities, search services, storage and retrieval, computer-based diagnostics of everything from cars to hearts, facsimile and electronic mail transmission services, specialized microcomputer programming, and so on. But as of this decade, the private and public bureaucracies are glutted with information workers. No more can be easily absorbed. The school systems are shrinking as the baby boom rumbles away; "lifelong education" has yet to become a reality; and the primary information service industries such as finance, law, and advertising are increasing at roughly the same rate as GNP.

FOOTNOTES

[1] Machlup, *The Production and Distribution of Knowledge in the United States*, Princeton University Press, Princeton, New Jersey, 1962, p. 400.

[2] Bell, *The Coming of Post-Industrial Society*, Basic Books, New York, 1973, pp. 126-127.

[3] C. Clark, op. cit., suggested that economic development through the agricultural, industrial, and services stages is characterized by shifts in the labor force and share of GNP to each sector.

[4] Edward F. Denison, "Some Major Issues in Productivity Analysis," *Survey of Current Business*, Vol. 52, No. 5, Part II, May 1972.

[5] D. Jorgenson and Z. Griliches, "The Explanation of Productivity Change," *Survey of Current Business*, Vol. 52, No. 5, Part II, May 1972.

CHAPTER EIGHT

THE PUBLIC BUREAUCRACIES

> The market system approaches the government through the legislature. This relationship, though highly visible, is with the branch of government which has been declining in importance. The technostructure and the planning system have their relationship with the public bureaucracy. This association is far more discrete; it is also with the branch of government which, as public tasks become more complex, is strongly ascendant.
>
> John Kenneth Galbraith,
> Economics & the Public Purpose
> Houghton-Mifflin, Boston, 1973

> Bureaus specialize in the supply of those services the value of which cannot be exchanged for money at a per-unit rate... As a consequence of the above, bureaus cannot be managed by profit goals and 'the economic calculus.'
>
> Ludwig von Mises, Bureaucracy
> Yale University Press, New Haven, 1944

> Bureaus are non-profit organizations which are financed, at least in part, by a periodic appropriation or a grant.... They specialize in providing those goods and services that some people prefer be supplied in larger amounts than would be supplied by their sale at a per-unit rate.
>
> William A. Niskanen, Jr.,
> Bureaucracy & Representative Government
> Aldine-Atherton, Chicago, 1971

An essential feature of a technocratic society is the bureaucracy. Bureaucratic enterprises appear both in the private and public sectors. Their hierarchical structure insures that the alter ego of the head is reflected throughout the chain of command. It also insures, however, that a change in the head will not cause a radical change in the operating rules and standards of the bureaucracy. This tension is built on purpose. A bureaucracy is at the core conservative--preserving a sense of continuity with the past--while superficially attendant to the direction given it by policy leaders. A good army fights and communicates the same way regardless of the field of battle. It is the leader's responsibility to decide which battles to fight; it is the bureaucracy's duty to execute the decision in a predictable, if not creative, fashion. Karl Marx's delight with bureaucracies is clear,

> "Bureaucracy is a circle no one can leave. Its hierarchy is a *hierarchy of information*. The top entrusts the lower circles with an insight into details, while the lower circle entrusts the top with an insight into what is universal, and thus they mutually deceive each other...." (in Bell, *op. cit.*, pp. 82-83)

A bureaucracy is essentially an information producing, distributing, and consuming organism. Bureaucracies plan, coordinate, command, evaluate, and communicate. They process information. They survey, gather intelligence, write reports.

In this chapter, we investigate the dimensions of the public bureaucracy. In Chapter 9, the other half of the "planning sector"--the private bureaucracy--will be investigated in more detail, and the consolidated accounts of the whole secondary information sector will be presented. The Federal Government is conceptualized as an enormous and elaborately organized multiproduct firm, producing both information and noninformation outputs. The informational inputs and outputs of the firm are measured in detail for 1967, and a time series (1958 to 1970) is built. State and local government bureaucracies will not be discussed here, although they exceed the Federal Government in terms of total budget. The reason is pragmatic: the Federal budget is consolidated, systematic, and relatively straightforward to analyze, whereas the State and local budgets are hopelessly unique.

THE FEDERAL INFORMATION INDUSTRY

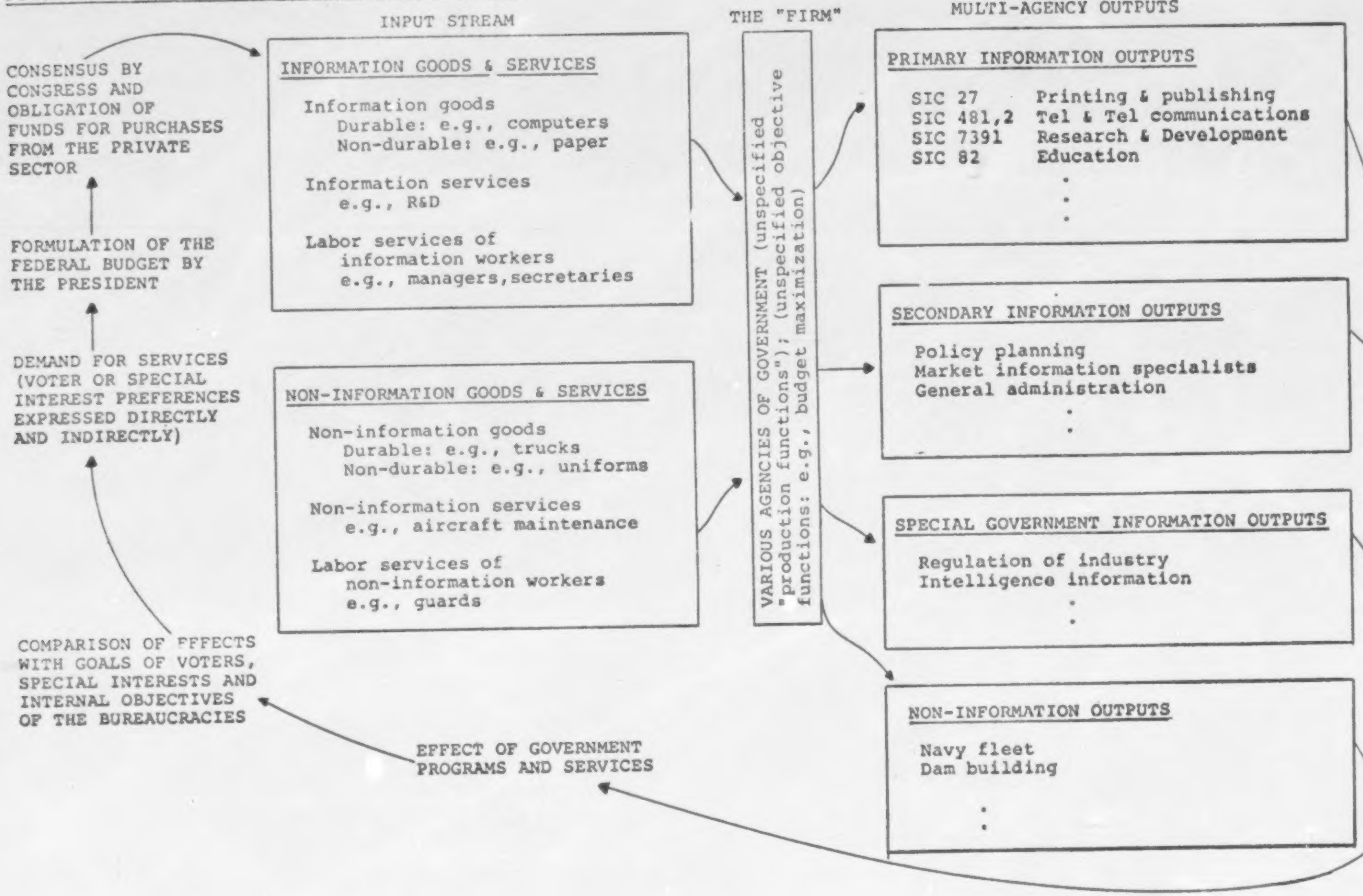
The Federal information industry can be conceptually described as a multiproduct firm, with a definable stream of inputs and outputs, operating in a market environment that determines the supply, demand, and price of its services.

The "marketplace" in which the firm operates is drawn in Figure 8.1. A demand for a variety of services is transmitted to the firm through constituent or special interest preferences. These demands are revealed directly (through the vote) or indirectly, through a variety of private lobbying activities. In addition, a demand for bureaucratic output is generated internally by the bureaucracies themselves, for reasons that may be only loosely coupled with externally felt demand.

In 1974, the Federal government spent $111 million advertising itself, placing it somewhere between the amounts spent by Colgate-Palmolive Company and R.J. Reynolds. This is in addition to the $260 million worth of free advertising offered as a public service. The government knows quite well that it is selling its output, even though no explicit market transaction occurs other than mandatory taxation.

These real or perceived demands are translated into a budget, formulated by the President and negotiated with the Congress. Once a consensus is reached regarding the types and levels of

FIGURE 8.1: THE FEDERAL INFORMATION INDUSTRY


INPUT STREAM
THE "FIRM"
MULTI-AGENCY OUTPUTS
CONSENSUS BY CONGRESS AND OBLIGATION OF FUNDS FOR PURCHASES FROM THE PRIVATE SECTOR
FORMULATION OF THE FEDERAL BUDGET BY THE PRESIDENT
DEMAND FOR SERVICES (VOTER OR SPECIAL INTEREST PREFERENCES EXPRESSED DIRECTLY AND INDIRECTLY)
COMPARISON OF EFFECTS WITH GOALS OF VOTERS, SPECIAL INTERESTS AND INTERNAL OBJECTIVES OF THE BUREAUCRACIES
EFFECT OF GOVERNMENT PROGRAMS AND SERVICES
INFORMATION GOODS & SERVICES
Information goods
Durable: e.g., computers
Non-durable: e.g., paper
Information services
e.g., R&D
Labor services of information workers
e.g., managers, secretaries
NON-INFORMATION GOODS & SERVICES
Non-information goods
Durable: e.g., trucks
Non-durable: e.g., uniforms
Non-information services
e.g., aircraft maintenance
Labor services of non-information workers
e.g., guards
VARIOUS AGENCIES OF GOVERNMENT (unspecified "production functions"); (unspecified objective functions: e.g., budget maximization)
PRIMARY INFORMATION OUTPUTS
SIC 27 Printing & publishing
SIC 481,2 Tel & Tel communications
SIC 7391 Research & Development
SIC 82 Education
SECONDARY INFORMATION OUTPUTS
Policy planning
Market information specialists
General administration
SPECIAL GOVERNMENT INFORMATION OUTPUTS
Regulation of industry
Intelligence information
NON-INFORMATION OUTPUTS
Navy fleet
Dam building

outputs that the firm will produce next year, an obligation for the purchases of inputs enters. Whereas firms in the private sector must await the decision of the marketplace before they can determine the level of output for the next time period, the Federal firm removes the market uncertainty *ex ante*, and can hence know the total cost before any output *is* "sold."

The multiproduct firm is organized into agencies, although the outputs of the agencies are far from homogeneous. The various agencies purchase a variety of goods and services from the private economy, which are divided into purchases from the primary information sector (as discussed in Chapter 4) and purchases from noninformation industries. The firm may buy computers, facsimile machines, file cabinets, and paper clips from the primary sector; and it may hire managers, lawyers, economists, and secretaries. This bundle of resources enters the firm as the "information inputs." By symmetry, the firm may purchase trucks, fuel oil, uniforms, and beefsteak from the noninformation industries; and it may hire guards, janitors, tank drivers, and pilots. The bundle enters the firm's production function as the "noninformation inputs."

The various divisions of the firm can each be characterized by a unique production function, although for the purpose of this chapter those functions will remain unspecified. Similarly, the divisions of the firm behave according to an unspecified objective function. One objective may be to maximize the division's budget; another might be to minimize risk; a third might be to accelerate the welfare of its top management--with size, prestige, and celebrity status replacing salary as the numeraire; a fourth might be to maximize the present value of the top management's lifetime income, with expected future salaries in the private sector entering into the present decision making processes. Another objective might be to maximize social welfare, or total surplus for the economy as a whole. This analysis is indifferent as to the actual objective function assumed, although more detailed studies of bureaucracies can reveal distinct differences in behavior depending on which objective is used. The binding constraint is assumed to be either financial or labor resources.

The informational and noninformational inputs enter the firm's production function and are converted into a variety of outputs. Some outputs have clearly defined analogs in the primary sector. For example, the Government Printing Office is the Federal version of a large private printing and publishing firm, in SIC 27. The telecommunications networks built and maintained by the Defense Communications Agency and the Federal Telecommunications System together constitute a firm that, if it were private, would belong to SIC 481. In addition, the Federal information firm produces a variety of "secondary" outputs of the type discussed in Chapter 9. These are information services of a strictly planning, coordinating, and managing sort--activities that take place in all firms, regardless of whether they are members of the primary information sector or part of the noninformation sector. Also, the Federal information firm produces outputs which are unique to itself, and have either weak analogs in the private sector or none at all. For example, the domestic and foreign intelligence communities generate a tremendous volume of information for internal consumption. Unless one counts industrial espionage as a secondary activity of the private sector, this type of information is strictly a government function. Lastly, the Federal government produces a number of strictly noninformational outputs. The construction of the Tennessee Valley Authority dam system is a prime example, the U.S. Navy carrier fleet is another. Income transfer and redistribution programs are a third. These outputs are noninformational public goods for the most part, or noninformational private services in others. Note that the informational costs of administering these programs are embedded in the secondary information sector of our accounts.

A major simplifying assumption is made. We cannot know precisely which input costs are allocated to each output. Hence we assume that the informational inputs in toto represent the total cost of providing all information services; the noninformation inputs by assumption are converted into noninformational outputs. This assumption is not as crude as it may seem at first glance. In private sector multiproduct firms, the precise cost allocation between different lines of business cannot be precisely stated either. It is currently a matter of severe contention between the Federal Trade Commission and large corporations whether these data can even be generated. For example, the FTC needs line of business data to establish the profit levels associated with each output, and to determine whether any internal cross-subsidies result in anticompetitive practices. The Federal Communications Commission is contending with the Bell system over internal cost allocations, again to assess whether a cross-subsidy is occurring, and if so, which way the subsidy is flowing.

The cost allocation problem in the Federal information industry is just as intractable. For example, although we may not be able to determine the unique amount of information processing costs allocable to each output, we can state with certainty that the total computer budget is jointly consumed by all the informational activities of the firm, whether the resources are used to produce R&D, accounting services, library search, or planning and strategic gaming.

This is a useful assumption because we can immediately restrict the output price of the information services to just equal the input price of the labor and capital resources. If these services were "sold" on a real marketplace, the price (or valuation) would necessarily be the total cost including profit; but with profit equaling zero, the price reduces to total input cost.

Inputs of the Federal Information Industry

Table 8.1 shows a summary of the informational inputs of the Federal Government. In 1967, the total cost of information

TABLE 8.1: INPUTS OF THE FEDERAL INFORMATION INDUSTRIES 1958 - 1970

($ Millions, Current)

	1958	1961	1963	1966	1967	1969	1970
Total information inputs[a]	19,311	27,058	37,049	48,142	50,483	57,589	62,833
Purchases of goods & services from primary information industries[a]	4,063	5,550	10,088	12,670	11,808	13,392	12,726
Purchases of R&D from private industry[b]	3,196	7,185	10,216	12,098	13,133	12,200	12,669
Employee compensation to info workers[c]	9,673	10,678	12,061	15,085	16,588	20,790	23,861
"Purchases" from state & local govt's[a]	453	574	684	2,923	3,117	3,607	4,412
Education	326	446	551	2,724	2,924	3,338	3,867
Other informational	127	128	133	199	193	269	545
Information purchases on transfer account[d]	783	1,381	1,559	2,323	2,498	3,870	5,066
Debt service allocated to general admin.[d]	1,207	1,745	2,492	3,109	3,400	3,835	4,203
Government information enterprises[d]	-64	-55	-51	-66	-61	-105	-104
Addenda							
Total Federal budget expenditures[e]	88,870	102,086	113,857	142,750	163,594	189,207	203,927
Total purchases of goods & services[a]	53,594	57,408	64,244	77,773	90,706	98,781	96,182
Ratios							
Information as % of total budget	21.7	26.5	32.5	33.7	30.9	30.4	30.8
Information employee compensation as % of total information inputs	50.0	39.5	32.6	31.3	32.9	36.1	38.0

---

[a] BEA, Input-Output Matrices for 1958, 1961, 1963, 1966, 1967, 1969, 1970, and estimates based on Appendix A.

[b] NSF, *Federal Funds for Research, Development and Other Scientific Activities*, e.g., Vol. XVII, Table C-97.

[c] Selective Service Commission, *Occupations of Federal White-Collar Workers*, October 1967.

[d] BEA, *National Income and Product Accounts*, Table 3.10, "Government Expenditures by Type of Function".

[e] OMB, *Budget of the United States*, FY 60-72, and *Appendix*.

resources was $50.5 billion, of which only $11.8 billion was in the form of direct purchase of goods and services from the primary information sector. These purchases are outlined in detail in Appendix 3 (Vol. 2) and Appendix 4 (Vol. 8). The Federal information industry purchased $13.1 billion in R&D from the private sector, mostly in development of new weapons and space systems for the Department of Defense and NASA.

The next item in Table 8.1 is "employee compensation to information workers," accounting for $16.6 billion in 1967. This estimate was derived from Civil Service Commission data on the occupational and compensation structure of Federal employees, as reported in detail in Chapter 7. Only those workers who perform purely informational tasks are included in this figure. Military workers who performed essentially administrative, planning, communications, or clerical duties were also included.

The next item shows Federal transfers to State and local governments for educational, training, or related purposes. These are considered as a purchase of educational services from an outside vendor, another government.

A portion of the debt service charges are also included as informational inputs. Debt service is mostly associated with deficit spending for income transfer, military purchases, foreign aid, and a variety of domestic programs. However, a portion of the program budget pays for the informational activities associated with planning, coordination, and management. We estimated these informational costs associated with general administration and allocated a portion (31%) of the debt service to information. The inclusion of debt service does not enter the GNP estimates in Chapter 9. It is included here only as a rough estimate of the Federal budget portion used for information. In the GNP accounts, only the employee compensation of Federal workers is accounted.

In 1967, approximately 31% of the total Federal budget was used for informational inputs--goods and services purchased from the primary sector, R&D services purchased from noninformation firms, educational services purchased from other governments, and so on.

The time series in Table 8.1 shows that the informational costs have been slowly increasing as a percentage of the total Federal budget. The fairly rapid increase between 1958 (22%) and 1966 (34%), when the informational activities increased by 50%, was temporarily halted as the Viet Nam war heated up. It will likely resume its upward march through the 1970's, as the Federal Government intensifies its dependence on information resources.

Outputs of the Federal Information Industry

The outputs of the Federal information industry have been organized into primary, secondary, and special government functions, shown in Table 8.2. A detailed breakdown is available in Appendix 8 (Vol. 8), showing where each office, agency, or

TABLE 8.2: OUTPUTS OF THE FEDERAL INFORMATION INDUSTRIES 1958 - 1970

($ Millions, Current)

	1958	1961	1963	1966	1967	1969	1970
TOTAL FEDERAL BUDGET EXPENDITURES[a]	88,870	102,086	113,857	142,750	163,594	189,207	203,927
Total budget less transfer payments & net int paid	61,935	68,425	76,977	97,572	111,117	123,682	126,127
TOTAL INFORMATION OUTPUTS	19,311	27,058	37,049	48,142	50,484	57,589	62,833
Info as % of total budget	21.7	26.5	32.5	33.7	30.9	30.4	30.8
Info as % of total budget less transfers	31.2	39.5	48.1	49.3	45.4	46.6	49.8
Total Primary Information Outputs	9,274	16,020	20,580	32,436	34,579	37,557	43,145
SIC 27 Printing & publishing	183	192	224	238	236	252	409
SIC 481,2 Telephone & telegraph communications	1,284	1,368	1,660	2,257	2,970	3,159	2,969
SIC 60 Banking	55	95	180	112	151	155	131
SIC 61 Credit agencies	58	621	524	679	706	857	928
SIC 63,4 Insurance carriers and brokers	284	644	536	763	900	966	1,684
SIC 6531 Real estate agents, brokers, managers	239	533	589	690	458	410	450
SIC 7311 Advertising agencies	2	10	9	20	15	18	48
SIC 7351 News syndicates	98	105	125	143	161	169	185
SIC 7361 Employment agencies	76	165	229	312	510	601	773
SIC 737 Data processing services	200	541	785	1,148	1,445	1,908	2,273
SIC 7391 Research & development	4,570	9,059	12,495	15,320	16,529	15,847	16,448
SIC 7392 Management & business consulting	99	119	165	233	240	309	226
SIC 8011 Physicians offices (prorated)	73	257	239	309	386	831	835
SIC 811 Legal services	141	165	230	223	306	384	616
SIC 82 Education	1,590	1,872	2,321	9,595	9,218	11,299	14,543
SIC 8231 Library services	30	33	39	71	69	77	214
SIC 8931 Accounting and bookkeeping services	292	241	230	323	279	315	413
Total Secondary Info "Quasi-Industry" Outputs	5,469	5,499	10,381	8,711	7,499	10,881	9,517
Policy planning	133	218	231	343	370	428	387
Market information specialists	32	73	156	206	138	252	442
Gen'l administration & management	5,304	5,208	9,944	8,162	6,991	10,201	8,688
Of the civilian bureaucracy (net primary)	3,394	3,244	7,928	5,764	4,138	6,590	4,526
Of the military bureaucracy (net primary	1,910	1,964	2,066	2,398	2,853	3,611	4,162
Total Special Government Functions	4,568	5,539	6,088	6,995	8,406	9,151	10,171
Regulation of industry	77	212	230	348	486	601	706
Intelligence information	4,011	4,415	4,599	5,061	5,255	5,824	6,227
Foreign intelligence information	3,525	3,692	3,819	4,096	4,220	4,626	4,875
Domestic intelligence information	486	723	780	965	1,035	1,198	1,352
Economic planning info and data	40	88	97	119	147	209	346
Diplomacy & foreign policy info	242	214	344	552	1,531	1,369	1,466
Info services provided gratis to private sector	198	610	818	915	987	1,148	1,426
Ratios							
Primary info as % of total info	48.0	59.2	55.5	67.4	68.5	65.2	68.7
Secondary info as % of total info	28.3	20.3	28.0	18.1	14.9	18.9	15.1
Special function info as % of total info	23.7	20.5	16.5	14.5	16.6	15.9	16.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] All outputs are estimated from The U.S. Budget, the Appendix, and Special Analyses.

program was assigned and providing a functional description of each primary output.

The 17 primary information industries listed in Table 8.2 accounted for $34.6 billion in output. The two largest industries, R&D and education, were mostly purchased directly from either the private sector or other governments. The other primary outputs were produced in-house, using government information workers and resources.

The secondary activities include those functions which are specifically concerned with policy planning and top management (e.g., Office of the Secretary), or as a general management function not tied to a particular primary output. This category also includes a small residual category of unallocable information resources.

The special government functions, such as regulation of industry, intelligence information, and economic information services, accounted for $9 billion in 1967. As a percentage of the total Federal information outputs, these special functions have actually declined, from around 24% in 1958 to about 16% in 1970. However, in absolute terms, they have grown very rapidly--economic planning and information gathering activities have increased eightfold in current dollars, regulation of industries has increased tenfold, diplomatic information gathering has multiplied sevenfold, and information services provided gratis to the private economy (such as FAA airport control) has increased elevenfold.

Paper Work

The public bureaucracy is a planning and coordinating resource. Part of the Federal government's bureaucracy necessarily communicates with "outside" entities--private firms and State and local governments. The bureaucracies "talk" to each other in managing the economy. And that volume of bureaucratic chatter has grown to stupendous heights in the past 50 years.

The National Commission on Federal Paper Work reports that "Federal agencies are today churning out forms, reports, and assorted paper work at the rate of over 10 billion sheets per year. That's 4-1/2 million cubic feet of paper. All of this paper costs the American economy $40 billion per year."[1] Senator Cranston estimated that there are 12,000 laws requiring reports from the public resulting in 10,000 different forms; and that there are 10,000 government attorneys who draft, revise, and enforce government regulations. This does not include the private attorneys who work on filling out forms, complying with Federal regulations and otherwise coordinating with the public bureaucrats.

Anecdotes are not research, but they can be fun. The Aircraft Owners and Pilots Association complained that the 1974 Code of Federal Regulations was 45,000 pages long and filled 7-1/2 feet of shelf space. The 1975 edition, to no one's relief, was 60,000 pages long and filled 10 feet of shelves. Current Federal laws require that X-rays used to inspect the welded seams of nuclear power plants be kept for 40 years. But the X-ray film deteriorates in about seven years and becomes unreadable. And the State of Maryland refused to accept a $60,000 grant from HEW for a consumer education program because the cost of completing the necessary forms would chew up about $45,000.

Some anecdotes are more serious. It takes 21 separate documents to get one Indian into a nursing home. It recently took 800 pounds of paper to inform a tribal official of one new law. An oil company spent $17 million and used 475 full-time workers to file government reports other than taxes. From recent testimony following the oil embargo, it seems that the government still knows very little about the operations of oil firms. The Department of Agriculture has 989,000 cubic feet of records. Last year, USDA increased its paper store by 64,000 cubic feet--or 36,500 file drawers. The department spends $150 million a year just printing forms.

The Chairman of the Board of Eli Lilly and Company complained,2

> "...we spend more man-hours filling out government forms or reports than we do on research for cancer and heart disease combined."

The index of information submitted by Lilly to the EPA on one product was 153 pages long. Each entry in the 153 pages refers to a document from 3 to 3,000 pages in size.

The Paper Work Commission estimates that about $15 billion is spent by the Federal Government in processing paper work. Small businesses spend about $18 billion completing required forms; the printing bills for federal forms is about $1 billion per year; another $1 billion is spent on directives accompanying the forms; and another $1.7 billion is spent to file and store forms. These figures do not even include the paper-work costs of large corporations and State and local governments.

Incidentally, the Paper Work Commission employs 140 information workers. The House hearings on the Federal paper work burden produced a 7-volume 2,285 page treatise.

We draw no conclusions, since we have done no analysis. This is simply a description of how large the Federal bureaucracy has become, and it raises the question of how effective these resources are in planning, coordinating, and managing the economy. Is this staggering informational machine a drag on the economy? Do we need such a large bureaucracy to deal with the private sector? Are the bureaucracies a source of mischief, or a necessary check and balance on the private bureaucracies? These kinds of questions are not easily answerable, but should be asked again and again as both corporate and governmental abuses are exposed, and as we begin to form images of governance in an information economy.

FOOTNOTES

[1] R.D. Wood, "Paperwork, Paperwork," in *Washington Post*, July 9, 1976.

[2] M. Mintz, "Drug Firms Oppose U.S. Price Audit," *Washington Post*, July 9, 1976.

CHAPTER NINE

THE SECONDARY INFORMATION SECTOR

> To perfect and guide the organization in which the specialist serves also requires specialists. Eventually not an individual but a complex of scientists, engineers and technicians; of sales, advertising and marketing men; of public relations experts, lobbyists, lawyers and men with specialized knowledge of Washington bureaucracy and its manipulations; and of coordinators, managers and executives becomes the guiding intelligence of the business firm. This is the technostructure. Not any single individual but the technostructure becomes the commanding power.
>
> John Kenneth Galbraith,
> Economics & the Public Purpose
> Houghton-Mifflin, Boston, 1973

Not all information services produced in the economy are sold in primary information markets. In fact, a majority of information services are produced by noninformation firms and consumed internally. In this chapter, we define and measure the private bureaucracies--that portion of every noninformation firm which is engaged in planning, coordinating, managing, and communicating. In Chapter 8 we saw the other part of the secondary information sector--the public bureaucracy. Here also we bring the two pieces together and measure their share of GNP.

Information Quasi-Industries: Definition

Every noninformation firm produces and consumes a variety of informational services internally as part of its operation. Every large firm needs a planning capability, financial control and analysis, a communications network, computer processing, typing, filing, duplication services, and so on. The private bureaucracies consume a tremendous amount of both capital and human resources in producing these overhead information services. Their inputs are computers, facsimile machines, laboratory equipment, office buildings, office machines, telephones, and trash baskets. They hire managers, research scientists, programmers, accountants, typists, and librarians. These resources are organized into production units that play a purely informational role. Large corporations are likely to create a "planning group," "R&D group," "electronic data-processing group," "advertising group," etc. Each unit has a well defined technology--with recognizable inputs and outputs and can be conceptualized as a "quasi-firm" embedded within a noninformation enterprise. Its information producing, processing, and distributing activities are ancillary to or in support of the main productive activity. For example, if an automobile manufacturer installs a data-processing facility in house, hires programmers and analysts, leases peripheral equipment, and extends the facility through a private data network, then this would be a clear case that a "quasi-EDP firm" has been created within the firm. These quasi-firms have direct analogs in the primary information sector. In many respects, the economics of the quasi-firm are indistinguishable from those of an established independent data-processing vendor selling its services to the auto manufacturer.

An industry is normally defined in terms of homogeneous inputs and outputs. When quasi-firms are aggregated horizontally, they are termed informational quasi-industries. For example, the automobile industry is conceptually bound by common inputs (steel, metal-working equipment, assembly plants, automobile parts, assembly workers, trucking facilities, and managerial activities) and outputs (cars, trucks). The input side is an exact statement of the firm's technology in the short run. It describes not only the capital/labor ratio, but disaggregates the various types of capital and the various types of labor exactly. By the same logic, the "quasi-industries" are also identifiable by common technologies (inputs) and products (outputs).

Table 9.1 contains a partial list of primary information industries which are replicated within most noninformation firms. Each activity in Table 9.1 corresponds exactly to an identifiable SIC-based establishment, even though the activity is contained completely within a noninformation establishment.

It is a matter of internal organizational habit and managerial discretion whether firms choose to build in-house facilities or purchase the same services from outside vendors. For example, a small hotel (a noninformation industry) may decide to purchase all of its accounting services from an outside accounting firm (a primary information industry) rather than develop in-house facilities. The effect of the decision is to raise the output of the primary information sector by the amount of the purchase. Hence, the value-added share of the primary sector (i.e., wages, profits, and taxes) increases, and we measure it in the National Income Accounts. But if the hotel builds its own accounting quasi-firm, no interindustry transaction is recorded other than the purchase of the goods necessary to conduct the activity. Now, it is clear that the outputs of the primary and secondary accounting firms are identical, namely accounting services. And it is also clear that the inputs are identical, namely accountants, clerks, filing cabinets, computer time, telecommunications, etc. But whereas the primary firm has a known output price (sum of intermediate inputs and value added) the quasi-firm's output is "buried" as part of the price of its joint noninformational good or service. A fraction of the price of a hotel room pays for the accounting information service necessary to deliver the lodging. This "price" becomes the embodied information which the consumer purchases jointly with another good.

TABLE 9.1: PARTIAL LIST OF INFORMATION QUASI-FIRMS WITHIN NON-INFORMATION ENTERPRISES

QUASI-INDUSTRY	EQUIVALENT TO IO#	EQUIVALENT TO SIC #	INPUTS	OUTPUTS
Electronic data processing services	7301	7392	Computer hardware, peripherals programming, consulting	EDP services, e.g., accounting, payroll, inventory, MIS
Advertising	7302	731	Services of writers, artists, account mgrs, office & other facilities; photocomposing and art equip; video & film equip	Placing time in media, producing advertisements, designing advertisement campaigns
Letter typing service	7301	7339	Secretaries, typewriters, composers, stationary, desks, office space	Letters, business communications
Duplicating service	7301	7339	Xerox machines, operators, paper	Copies
Printing service	2605·	2752	Printing presses, folding and binding equip., platemaking equip, pressmen, operatives	Firm's stationary, forms, brochures etc. not contracted from outside vendors
Direct mail service	7301	7331	Addressographs, computer files, labeling & stamping machines, paper & envelopes, operators, facilities	Addressing service, mailing service, mailing list management, etc.
Research & Development	7301	7391	Laboratories, EDP, scientists, technicians, support staff, facilities	R&D knowledge, invention, patents, processes, evaluations
Press clipping service	7301	7399	Newspapers, clerks, facilities	Newsletter - customized info svc
Business management	7301	7392	Services of managers, telecommunications, EDP, facilities, support staff, consulting economists, technicians, scientists, marketing	Planning
Accounting & bookkeeping services	7303	8931	Services of accountants, bookkeepers, supporting clerical staff, accounting machinery, EDP, telecommunication facilities	Accounting information, billing, etc.
Legal services	7303	8111	Attorneys, facilities, telecommunication, EDP, supporting clerical staff & facilities	Counsel, litigation, letters, briefs, etc.
Patent & copyright holding	7102	6794	Knowledge products, e.g., books, records, inventions	Royalty income
Library services	7704	8231	Books, filing cabinets, shelves, librarians	Information storage and retrieval services, research services

Some information quasi-firms are extremely well defined as cost centers within the enterprise. A profit-maximizing enterprise with adequate internal cost allocation and control mechanisms knows the output price of its quasi-firms. It knows, for example, the price it is paying for its in-house data-processing facilities, and has a good idea of the competitive price offered by the counterpart EDP firm in the primary information sector. Ignoring for a moment the organizational or scale effects of maintaining close in-house informational control, the enterprise must constantly evaluate whether to discontinue the in-house "firm" and buy from the outside, or whether to do the opposite. The "make or buy" decision can be well specified and solved, for it is nothing more than a project evaluation. The enterprise is paying an opportunity cost on the resources committed to the quasi-firm, and only continues supporting the quasi-firm if its imputed rate of return is higher than would be experienced with alternate forms of investment. At the very least, the quasi-firm must be competitive with the primary sector substitute. Stated in this manner, in-house quasi-firms must earn zero profit (or better) if they are allowed to exist by rational management. This is true because the primary sector substitute is returning zero profit to its owners as part of the price it charges for its services. The quasi-firm, if it is at least as efficient as the primary firm, must purchase the same amount of inputs (e.g., capital goods, current goods, services, wages) as the primary firm. The difference between the primary firm's output price and the secondary firm's cost should equal the profits of the primary firm.

Arrow and others[1] have argued that firms integrate vertically, partly to economize on the information flows necessary to coordinate complex productive activities. Managers have learned that "hands-on" access to both upstream and downstream information is a prerequisite for effective control, and that the communication gaps, time delays and uncertainties are often intolerable. The small hotel discussed previously may find that it cannot tolerate the lag or delay in dealing with an outside firm, and instead decide to produce accounting service internally where management can exercise faster and better control. This phenomenon is well known in the advertising industry, with firms discovering that it is cheaper to build an in-house agency rather than purchase services from an outside vendor. There are now two quite distinct yet similar advertising industries--a primary and secondary. The same phenomenon is occurring in electronic data processing (EDP), where both time-sharing firms and extensive private data processing and telecommunications networks exist.

It is precisely this phenomenon that is expanding the size of the secondary information sector. The informational requirements of noninformation firms are increasing, partly because better information leads to more efficient and productive use of resources, and partly because bureaucracies tend to develop a life and momentum of their own. And as those bureaucracies are born, they in turn generate their own requirements for information both from within and without the firm.

One of the more illustrative cases of a quasi-industry is to imagine that there exists in the primary information sector something called a "Reservations industry." The hypothetical industry sells its services exclusively to other industries: airlines, trains, hotels, box offices, and automobile rentals. It maintains a national high-speed data network, distributed computer facilities, and an extensive system of hard copy, facsimile, and CRT terminals which it leases to its customers. The reservations industry also maintains a large staff of systems analysts, programmers, and salesmen. The service is so good that no firm builds it own reservations system--all such services are purchased from the reservations industry. As new firms join the reservations system, they are linked into a national network with nothing more than a change in software and distribution of some new terminal equipment. Each new customer hence gains the scale economies implied by a natural monopoly.

There is no such industry in the primary sector. It is at present entirely a creature of the secondary information sector. But its existence as a hidden quasi-industry makes it no less interesting from an analytic viewpoint. And its omission from the information accounts would be unfortunate, for it represents both a significant investment of economic resources and an innovative way for far-flung transnational industries to conduct their business. A casual glance at magazine advertisements will reveal that auto rental firms don't sell transportation, hotels don't sell room service, and airlines don't sell safety performance. Rather, they emphasize timely and efficient reservations, executed through a global information network.

Information Quasi-Industries: Measurement

The strategy adopted in measuring the secondary information sector is to tear firms apart in an accounting sense into an information activity and a noninformation activity. The informational side of the firm sells its services on a fictitious account to the noninformation side.

The noninformation part of every firm has well-defined inputs. For example, a steel firm buys iron ore, trucks, cranes, smelters, rollers, factories, and warehouses. And it hires furnacemen, smeltermen, pourers, cranemen, derrickmen, and drivers. The noninformation side of the firm doe not purchase any resources for producing informational services. Similarly, the information side of the firm only purchases information-producing resources, such as computers, office buildings and telephone service. The information side of the firm has no use for matter and energy unless it is directly necessary in producing information services.

The quasi-industries listed in Table 9.1 are not easily separable into accounting units because few firms keep such records and because quasi-firms share common facilities. For example, it would be quite difficult to break down the allocation of the Sears office building into its constituent information quasi-firms, even though all the space is used in the provision of information services. Certain imputations can be made, since the technologies of the primary sector counterparts are well known. If a secondary information industry hires a printer, lawyer, or programmer, wages can be clearly allocated to the "printing firm," the "law firm," and the "data-processing firm." However, this exercise is not necessary to measure the secondary sector's share of GNP if we can make one simplifying assumption: The information quasi-industries as a group can be said to exactly consume all the information resources purchased by the firm, i.e., (i) the wage services (employee compensation) of all information workers, as defined in Chapter 7 and measured in Table 7.10; (ii) the capital services of information machines such as computers, copiers and printing presses, measured as capital consumption allowances or depreciation, and (iii) a specifiable portion of the intermediate inputs of the enterprise, such as, telephone service, office space, paper, and any information goods or services that are not produced by the quasi-industry but instead are purchased from the primary information sector.

How the enterprise distributes these resources among its various information quasi-firms is a matter of its own discretion for which we have very little information. But we can unambiguously state that all the information inputs of a noninformation firm are consumed entirely by the quasi-firms. Armed with this simplifying assumption, we can now measure the value-added portion of the secondary information sector.[2]

In the next section the share of GNP originating in the secondary information sector is measured. Note that this share is conceptually and empirically distinct from the primary information sector.

Gross Product of the Secondary Information Sector

The first two inputs discussed above are components of value added, and directly enter the estimates of gross product in the secondary information sector. Intermediate purchases of goods and services do not enter the value-added account; they will be discussed separately in Chapter 10 when we estimate output prices for the quasi-industries' services.

The returns to information labor and capital factors of production comprise the following items:

(i) Employee compensation of information workers;

(ii) Labor income of proprietors and unpaid family workers performing informational tasks; and

(iii) Capital consumption allowances taken on information machines.

By assumption, all indirect business taxes, profits, rental income, and the like, are allocated to the noninformation side of the firm. For example, all the profits earned by a steel firm accrue to the noninformation sector, even though a portion of the value of steel originated in the provision of information services.

Two other methods were considered and rejected. A more inclusive method is to allocate a portion of profit-type income and taxes to the secondary information sector. In the Schumpeterian tradition,[3] one might allocate those profits which are deemed supernormal--higher than the competitive rate of return on capital--on the assumption that they were earned on informational advantages gained by the firm's research and development, marketing, planning, or control activities. This method assumes that manufacturing technologies diffuse fairly rapidly in competitive settings. When a manufacturing process is protected by patent, or where entry into an industry is barred for some institutional reason, a technical advantage can generate monopoly profits for the firm. But more often, it is the informational advantages such as advertising, vertical integration, concentration, and better internal organization which contribute to profit levels higher than normal, net of technical differences between firms. Schumpeter's views of oligopoly are that a firm's supernormal profits are associated with temporary advantages accruing from innovativeness and superior technology. Firms that cannot maintain an information-rich environment are soon eclipsed by more aggressive entrants in a cyclical "creative destruction." The old oligopolist soon stops earning supernormal profits, and instead receives only the competitive returns. In Schumpeter's view, the secondary sector should include all supernormal profits, as rewards to knowledge.

We have adopted the most restrictive definition of value added in measuring the secondary information sector. No corporate profits of the noninformation industries enter our secondary sector accounts. This was done for two reasons: (i) the entire study tends to err on the side of caution, and (ii) it is very difficult to separate normal profits from excess profits. [One study that is suggested by this discussion is to estimate a firm's profits as a function of the secondary information activities. Within a homogeneous industry, variance between firms' profit margins might be explained by differences in their internal planning bureaucracies.]

Table 9.2 shows a summary of the gross product originating in the secondary information sector. The public and private bureaucracies are measured together to produce a consolidated account of the secondary sector. The table is directly comparable to Table 4.10 on the primary sector gross product.

In 1967, approximately 21% of GNP originated in the secondary information sector--18.8% in the private bureaucracies and 2.4% in the public bureaucracies. Of the $168.1 billion in value added, some 83% ($139.4 billion) originated in compensation to information workers and 3.5% ($5.8 billion) represented

Table 9.2 –Gross Product by Industry Total and by Components, in the Secondary Information Sector 1967

[Millions of dollars]

	Total valued added	Secondary information value added	Information percent of total
All industries, total (GNP)	795,388	168,073	21.1
Employee compensation	467,240	139,405	29.8
Profits and proprietors' income[a]	160,508	22,848	14.2
Capital consumption allowances	68,895	5,820	8.4
Other[b]	97,940	0	0
Private sector	[d]708.8	149,338	21.1
Employee compensation	382.2	120,670	31.6
Profits and proprietors' income	160.5	22,848	14.2
Capital consumption allowances	68.9	5,820	8.4
Other	97.9	0	0
Agriculture, forestry, and fisheries	26,733	467	1.7
Employee compensation	3,706	256	6.9
Profits and proprietors' income	12,790	189	0.1
Capital consumption allowances	5,670	22	0.0
Other	4,567	0	0
Mining	13,886	1,512	10.9
Employee compensation	5,188	1,117	21.5
Profits and proprietors' income	4,288	136	3.2
Capital consumption allowances	3,265	259	7.9
Other	1,134	0	0
Contract construction	36,102	13,243	36.7
Employee compensation	26,600	9,702	36.5
Profits and proprietors' income	6,360	1,819	28.6
Capital consumption allowances	1,961	1,722	87.8
Other	1,181	0	0
Manufacturing	223,729	57,880	25.9
Employee compensation	152,265	54,668	35.9
Profits and proprietors' income	36,316	1,171	3.2
Capital consumption allowances	17,354	2,051	11.8
Other	17,794	0	0
Nondurable goods	90,595	21,044	23.2
Employee compensation	55,793	19,504	35.0
Profits and proprietors' income	15,046	374	2.5
Capital consumption allowances	7,396	1,166	15.8
Other	12,360	0	0
Durable goods	133,134	36,836	27.7
Employee compensation	96,472	35,154	36.4
Profits and proprietors' income	21,270	797	3.7
Capital consumption allowances	9,958	885	8.9
Other	5,434	0	0
Transportation	32,040	8,115	25.3
Employee compensation	21,809	7,272	33.3
Profits and proprietors' income	2,214	522	23.6
Capital consumption allowances	4,745	321	6.8
Other	3,272	0	0

Table 9.2–Gross Product by Industry, Total and by Components, in the Secondary Information Sector, 1967–Con.

[Millions of dollars]

	Total value added	Secondary information value added	Information percent of total
Communication	**17,632**	**0**	**0**
Employee compensation	7,703	0	0
Profits and proprietors' income	4,401	0	0
Capital consumption allowances	2,462	0	0
Other	3,066	0	0
Electric, gas and sanitary services	**18,429**	**2,612**	**14.2**
Employee compensation	5,918	2,467	41.7
Profits and proprietors' income	4,885	34	0.7
Capital consumption allowances	3,693	111	3.0
Other	3,933	0	0
Wholesale and retail trade	**129,863**	**42,447**	**32.7**
Employee compensation	73,986	32,279	43.6
Profits and proprietors' income	23,536	9,585	40.7
Capital consumption allowances	6,680	583	8.7
Other	25,661	0	0
Finance, insurance, and real estate	**108,840**	**3,341**	**3.1**
Employee compensation	22,364	1,943	8.7
Profits and proprietors' income	36,811	1,084	2.9
Capital consumption allowances	16,754	314	1.9
Other	32,911	0	0
Services	**86,992**	**19,204**	**22.1**
Employee compensation	53,871	10,523	19.5
Profits and proprietors' income	23,399	8,244	35.2
Capital consumption allowances	6,311	437	6.9
Other	3,411	0	0
Government and government enterprises	**95,827**	**18,735**	**19.6**
Employee compensation	93,790	18,735	20.0
Profits and proprietors' income	1,962	0	0
Capital consumption allowances	0	0	0
Other	75	0	0
General government	**85,087**	**15,958**	**18.8**
Employee compensation	85,087	15,958	18.8
Profits and proprietors' income	0	0	0
Capital consumption allowances	0	0	0
Other	0	0	0
Rest of the world[c]	**4,510**	**517**	**11.5**
Employee compensation	40	453	–
Profits and proprietors' income	3,606	64	1.8
Capital consumption allowances	0	0	0
Other	864	0	0
Statistical adjustment	**805**	–	–

---

[a] "Profits and Proprietor's Income" includes all corporate profits and retained earnings of partnerships. The information component includes only the income of proprietor's who perform an information role. (i.e. selected managers)

[b] "Other" includes rentals and indirect business taxes.

[c] "Rest of the World" includes the rest of the world industry and the household industry.

[d] Private sector reported in billions of dollars.

depreciation charges taken on information machines. The balance was earned by proprietors performing information tasks.

For all noninformation manufacturing industries, nearly 26% of value added originated in the provision of in-house information services--again mostly in the form of employee compensation. Similar ratios were found in the transportation sector (25%), the trade sector (33%), and the service sector (22%).

Agriculture reported the least secondary information (1.7%), a curious item considering that information plays an important role in farming. The bulk of farm information is not generated internally, but originates in the private and public bureaucracies. Private chemical fertilizer, seed, and feed manufacturers maintain extensive research programs in farm management. Informational support, in the form of brochures, booklets or extensive help offered by technician-salesmen becomes an important part of the product's value and price. The public bureaucracy also supplies a tremendous amount of free information to the agriculture sector. In Appendix 8 (Vol. 8) we see how extensive the Department of Agriculture's information services have become. This direct public information subsidy is unmatched in any other sector, except for nuclear energy and health research.

The penetration of information machines as a source of secondary value added is clearly seen in the nondurable manufacturing sector, where 16% of all depreciation is taken on computers, communication equipment, copiers, typewriters and other office machines. The durable goods manufacturing sector (without the printing industry) allocated 9% of all capital depreciation to information machines. By contrast, less than 0.4% of depreciation in the agriculture sector was informational in origin.

Table 9.3 shows secondary gross product originating by industry. It is directly comparable to Table 4.9. Certain industries, such as chemicals, apparel, fabricated metal products, and transportation are heavily laced with information. Others, such as tobacco, electrical machinery, and motor vehicle manufacturers are still relatively conventional with respect to a buildup of secondary information activities.

Table 9.3 –Gross Product Originating by Industry in the Secondary Information Sector, 1967

[Millions of dollars]

	Total value added	Secondary information value added[a]	Information percent of total
All industries, total (GNP)	795,388	**168,073**	**21.1**
Agriculture, forestry and fisheries	**26,733**	**467**	**1.7**
Mining	**13,886**	**1,512**	**10.9**
Contract construction	**36,102**	**13,243**	**36.7**
Manufacturing	**223,729**	**57,880**	**25.8**
Nondurable goods	90,595	**21,044**	**23.2**
Food and kindred products	22,340	5,248	23.5
Tobacco manufacturers	3,490	254	7.3
Textile mill products	6,619	1,373	20.7
Apparel and other fabricated textile products	7,816	2,670	34.2
Paper and allied products	8,005	2,109	26.3
Printing, publishing and allied industries	10,718	565	5.3
Chemicals and allied products	16,687	5,266	31.6
Petroleum refining and related industries	7,050	1,337	19.0
Rubber and miscellaneous plastic products	5,626	1,702	30.3
Leather and leather products	2,244	520	23.2
Durable goods	**133,134**	**36,836**	**27.7**
Lumber and wood products except furniture	4,873	1,069	21.9
Furniture and fixtures	3,380	777	23.0
Stone, clay and glass products	6,597	2,035	30.8
Primary metal industries	18,009	4,350	24.2
Fabricated metal products	14,674	4,681	31.9
Machinery, except electrical	23,980	7,259	30.3
Electrical machinery	19,959	3,273	16.4
Transportation equipment and ordnance exc. motor vehicles	16,417	8,771	53.4
Motor vehicles and equipment	16,334	3,116	19.1
Miscellaneous manufacturing industries	3,305	1,140	34.5
Instruments	5,606	365	6.5
Transportation	**32,040**	**8,115**	**25.3**
Communication	**17,632**	**0**	**0**
Electric, gas and sanitary services	**18,429**	**2,612**	**14.2**
Wholesale and retail trade	**129,863**	**42,447**	**32.7**
Finance, insurance, and real estate	**108,840**	**3,341**	**3.1**
Real estate	82,686	2,764	3.3
Other	26,154	577	2.2
Services	**86,992**	**19,204**	**22.1**
Hotels personal and repair services except auto	14,307	3,740	26.1
Miscellaneous business services	11,919	6,535	54.8
Automobile repair and services	3,889	1,376	35.4
Motion pictures	1,690	0	0
Amusements except motion pictures	3,607	780	21.6
Medical, educational services and nonprofit organizations	34,365	6,773	19.7
Other	17,215	0	0

Table 9. 3—Gross Product Originating by Industry in the Secondary Information Sector, 1967—Con.

[Millions of dollars]

	Total value added	Secondary information value added[a]	Information percent of total
Government and government enterprises	95,827	18,735	19.6
Federal	40,559	7,693	19.0
General government	35,865	6,357	17.7
Government enterprises	4,694	1,336	28.5
State and local	55,268	11,042	20.0
General government	49,222	9,601	19.5
Government enterprises	6,046	1,441	23.8
Rest of the world	4,510	517	11.5
Statistical adjustment	805	–	–

[a] Includes labor income of information workers and capital consumption allowances on information machines.

Table 9.4 shows the components of secondary national income. Note that all rental income, profits and interest are zero. The business and professional proprietors who were not in the primary information sector were, upon further investigation, found to perform a variety of informational tasks. The reader is referred to Table 4.6 for a line by line comparison of national income originating in the primary and secondary information sectors.

Table 9.4—National Income by Type of Income of the Secondary Information Sector, 1967

[Millions of dollars]

	Total national income	Secondary information national income	Information percent of total
National income	655,805	162,253	24.7
Compensation of employees	471,915	139,405	29.5
Private	376,514	120,670	32.0
Military	18,842	3,348	17.8
Government civilian	76,559	15,387	20.1
Proprietors' income	60,974	22,848	37.5
Business and professional	48,894	22,659	46.3
Farm	12,080	189	1.6
Rental income of persons	19,736	0	0
Corporate profits and inventory valuation adjustments	79,261	0	0
Net interest	24,279	0	0

Table 9.5 shows a summary of the value added components by sector. For an expansion of this table showing the components for all industries at the 6-digit level, the reader is referred to Appendix 9 (Vol. 8).

TABLE 9.5: VALUE ADDED COMPONENTS OF THE SECONDARY INFORMATION SECTOR (20 ORDER)

($ Millions, 1967)

	EMPLOYEE COMPENSATION	NET[a] INTEREST	CAPITAL CONSUMPTION ALLOWANCES	INDIRECT[a] BUSINESS TAXES	PROPRIETORS'[b] INCOME	TOTAL SECONDARY INFORMATION VALUE ADDED
TOTAL SECONDARY INDUSTRIES	139,405.0	0	5,820.3	0	22,848.0	168,073.8
Total Private Sector	120,670.0	0	5,820.3	0	22.848.0	149,338.3
Total Public Sector	18,735.0	0	0	0	0	18,735.0
AGRICULTURE, FORESTRY, FISH	256.0	0	22.3	0	189.0	467.3
MINING & REFINING	2,391.0	0	317.4	0	141.0	2,849.4
CONTRACT CONSTRUCTION	9,762.0	0	1,721.5	0	1,819.0	13,242.5
MANUFACTURING	53,384.0	0	1,993.0	0	1,166.0	56,543.0
Non-durable goods	20,909.0	0	958.4	0	435.0	22,302.4
Food products	4,569.0	0	563.0	0	116.0	5,248.0
Textile & tabacco products	4,102.0	0	65.6	0	129.0	4,296.6
Chemical products	5,027.0	0	200.1	0	39.0	5,266.1
Non-durable manufacturing	7,211.0	0	129.7	0	151.0	7,491.7
Durable goods	32,475.0	0	1,034.6	0	731.0	34,240.6
Lumber,wood,paper products	3,465.0	0	248.2	0	242.0	3,955.2
Primary iron & steel	4,154.0	0	167.7	0	28.0	4,349.7
Misc durable manufacturing	5,543.0	0	83.4	0	195.0	5,821.4
Machinery & equipment	6,893.0	0	202.2	0	164.0	7,259.2
Electrical mach & equipment	3,487.0	0	109.3	0	42.0	3,638.3
Transportation equipment	8,933.0	0	223.8	0	60.0	9,216.8
TRANSPORTATION	7,272.0	0	321.4	0	522.0	8,115.4
Transportation & warehousing	7,272.0	0	321.4	0	522.0	8,115.4
UTILITIES (incl Gov't enterprise)	5,244.0	0	110.8	0	34.0	5,388.8
TRADE	32,279.0	0	582.7	0	9,585.0	42,446.7
REAL ESTATE	1,474.0	0	279.3	0	1,011.0	2,764.3
SERVICES	10,992.0	0	471.9	0	8,317.0	19,780.9
DUMMY INDUSTRIES[c]	453.0	0	0	0	64.0	517.0
GENERAL GOVERNMENT	15,958.0	0	0	0	0	15,958.0
Federal Government Wages	6,357.0	0	0	0	0	6,357.0
State & Local Wages	9,601.1	0	0	0	0	9,601.0

---

[a] Zero by definition. All net interest and indirect business taxes allocated to non-information.

[b] Proprietors' income includes the income of administrative managers and selected "unpaid family" (e.g., cashiers) working in non-information businesses.

[c] Incluces REST OF THE WORLD and HOUSEHOLD industries.

Final Demand for the Secondary Information Sector

The sales of the secondary information industries to final markets include only two recognizable and measurable items: (i) the exports of royalties and management fees by the R&D quasi-firms, and (ii) sales of R&D contracts to the Federal Government. In addition, Federal, State, and local governments maintain their own in-house secondary industries, as discussed in Chapter 8. The employee compensation of information workers who are employed in these secondary government industries are also included.

In 1967, the final demand for secondary information services amounted to only $27.4 billion, or 3.4% of GNP. Table 9.6 shows a summary of the major components of GNP.

Table 9.6 –Gross National Product of the Secondary Information Sector, 1967

[Millions of dollars]

	Total final demand	Secondary information final demand	Information percent of total
Gross national product	795,388	27,440	3.4
Personal consumption expenditures	490,358	0	0
Gross private domestic investment	120,829	0	0
Net exports of goods and services	4,937	1,586	32.1
Royalties	n.a.	1,586	–
Government purchases of goods and services[a]	180,188	25,854	14.3
Federal secondary information purchases	n.a.	14,812	–
State and local secondary information purchases	n.a.	11,042	–
Statistical adjustments	–924	–	–

[a] Includes federal purchases of R&D from non-information industries and employee compensation of information workers in the secondary gov't. information industries. (See chapter 8.)

(i) Personal Consumption

No personal consumption expenditures could be identified as originating with the secondary industries. A hypothetical example of such a household purchase would be a retail store charging a transaction fee for placing a catalog order or a major gasoline retailer charging a fee on credit card transactions. These types of explicit charges are minimal, and are assumed to be zero.

(ii) Gross Capital Formation

All gross capital formation in information structures and machines occurs as part of the primary information sector. When a noninformation industry invests in an R&D lab, or builds a computer facility, the output of the relevant construction or manufacturing industry in the primary sector is already allocated to primary GNP. That is, all sales of computers appear on the GCF account in Chapter 4, regardless of whether they were purchased by primary or secondary industries. An alternate method of producing the GCF account is to split investment by type of purchaser. All information capital purchased by the primary sector would be kept distinct from information capital purchased by the noninformation industries. This method was rejected as overly cumbersome. Instead, only depreciation allowances on the value-added account were separated into primary and secondary industries, as shown in Tables 4.10 and 9.2.

(iii) Exports of Royalties and Management Fees

Chapter 4 contained a discussion of royalty and management fees sold by the primary information sector. These exports covered only "unaffiliated foreigners," or sale of royalties to foreign-based firms not connected to the U.S. firms. The output of the secondary R&D quasi-firms represent the sales of royalties and management fees from U.S.-based multinational firms to their foreign subsidiaries. These direct (affiliated) sales are simply intrafirm transfers of knowledge for which an explicit charge is made. These transactions place on a real account the types of fictitious sales that we have been ascribing to the quasi-industries.

Most industries export only a minor amount of intellectual property to their affiliates, with the chemical, petroleum refining, motor vehicle, and aircraft industries the leaders in such transactions. Among the service industries, commissions earned in wholesale trade and brokerage and on real estate transactions account for over $400 million in direct exports. A variety of business services sold to foreign affiliates or subsidiaries accounts for another $278 million. In all, affiliated U.S. firms exported $1,568 million of technological or organizational knowledge in 1967.

(iv) Secondary Information Sector Sales to Governments

Federal, State, and local governments are final consumers of very few secondary sector outputs. The Federal Government purchased $8 billion in R&D from noninformation industries. These sales are defined as outputs of the R&D quasi-firms within noninformation industries. No other direct transactions are identifiable.

The outputs of the secondary industries' R&D establishments are sold on real account to the Federal Government, as opposed to the fictitious account of an intrafirm sale. Table 9.7 shows an overview of these R&D outputs. A more detailed look is available at the 108 order in Appendix 9 (Vol. 8). Another portion of secondary final demand includes the wages and supplements of government information workers in the various "secondary government industries" discussed in Chapter 8.

A totally unrecorded output of the secondary information industries involves "information products" purchased as part of a contract by the Department of Defense. DOD became concerned recently with the vast proliferation of redundant and conflicting management control systems and reports that are generated both by the Department and its contractors. In 1966, Deputy Secretary Cyrus Vance met with top industry leaders to discuss the problem. The select group estimated that:

> "...the multitude of paper studies, reports, management plans and related management requirements represented at least one out of every seven contracted dollars.... and there appears to be general agreement among both industry and Defense Department management that the estimate is realistic. In FY 1969, this estimate represented 4.4 billion dollars of the Defense budget."[3]

The "related management requirements" cited above include users' manuals on operating weapon systems, documentation, and other information products which are provided jointly with the procurement item itself. The cost of generating reports and product data can sometimes double the price of the procurement item; and when training and education are included, the physical item may represent a small part of the total system cost. This fact is ignored in the accounts.

The secondary public bureaucracies spent $7.7 billion at the Federal level, and $11.0 billion at the State and local levels on employee compensation to information workers. These exclude all government workers in the primary industries (e.g., education, postal service, printing). They include only "management," "planning," and other nonspecific overhead information tasks; and they include a large component of the intelligence community wages.

TIME SERIES OF THE SECONDARY INFORMATION SECTOR

Measuring the growth of the secondary information sector poses some severe methodological difficulties. The National Income Accounts offer no insights, since the secondary sector is entirely a nonmarket entity. However, a strategy was developed and the results are presented here.

The first step in producing a time series of the secondary information sector is to establish the 1967 secondary national income. This was done in detail, aggregating up the components

TABLE 9.7 : FINAL DEMAND COMPONENTS OF THE SECONDARY SECTOR (20 ORDER)

($ Millions, 1967)

	PERSONAL CONSUMPTION EXPENDITURES	GROSS CAPITAL FORMATION & INVENTORIES	NET EXPORTS	FEDERAL[a] PURCHASES (R&D ONLY)	STATE PURCHASES	TOTAL FINAL DEMAND
Total Secondary Industries	0	0	1,586.3	7,118.7	0	8,705.0
Total Private Sector	0	0	1,586.3	7,118.7	0	8,705.0
Total Public Sector	0	0	0	0	0	.0
AGRICULTURE FORESTRIES & FISHERIES	0	0	.2	.4	0	.6
MINING AND REFINING	0	0	166.8	11.5	0	178.3
CONTRACT CONSTRUCTION	0	0	12.8	191.2	0	204.0
MANUFACTURING	0	0	637.9	6,588.7	0	7,226.2
Non-durable goods	0	0	295.5	3,533.2	0	3,828.7
Food products	0	0	84.4	11.2	0	95.6
Textile & tobacco products	0	0	5.5	1.9	0	7.4
Chemical products	0	0	168.2	180.7	0	348.9
Misc non-durable manufacturing	0	0	37.4	3,339.4	0	3,376.8
Durable goods	0	0	342.4	3,055.5	0	3,397.9
Lumber, wood & paper products	0	0	23.6	5.5	0	29.1
Primary iron & steel manufacturing	0	0	20.2	17.8	0	38.0
Misc durable manufacturing	0	0	44.9	59.2	0	104.1
Machinery & equipment	0	0	114.7	78.5	0	193.2
Electrical machinery & apparatus	0	0	34.4	203.7	0	238.1
Transportation equipment	0	0	104.6	2,690.8	0	2,795.4
TRANSPORTATION	0	0	7.5	2.1	0	9.6
Transportation & warehousing	0	0	7.5	2.1	0	9.6
UTILITIES (inc government enterprises)	0	0	30.2	1.5	0	31.7
TRADE	0	0	92.3	0	0	92.3
REAL ESTATE	0	0	348.4	289.3	0	637.7
SERVICES	0	0	290.2	34.0	0	324.2
REST OF THE WORLD	0	0	0	0	0	0

---

[a] The Federal government financed $3.9 billion of R&D internally. The resources (building supplies, personnel) have already been accounted as outputs of the primary sector and as value added in the secondary government sector.

of national income to establish an estimate of 24.7%, or $162,253 million, as shown in Table 9.4. These national income data come directly from two sources: (i) the industry by occupation matrix of employee compensation, and (ii) the capital flow matrix. We cannot know at this level of precision what the components of national income were for years other than 1967, since the two critical data bases do not exist. However, we do know the total number of information workers--including both primary and secondary sector occupations--discussed previously in Chapter 7. Conceptually, total informational national income is a function of all employee compensation and proprietors' income paid to the information workers. A relationship between the number of information workers and national income is given in the following assumption:

$$(1) \quad \frac{L^P}{N^P} = \frac{L^S}{N^S}$$

where, L^P, L^S = the primary and secondary information work force

N^P, N^S = the primary and secondary information national income.

Or, an information worker in the primary sector, L^P, receives income (employee compensation, proprietors' income) in the same proportion as an information worker in the secondary sector. To make this assumption work, we rely on the discussion in Chapter 7 showing that the labor income of proprietors (who primarily work in the secondary information sector) is equivalent to the employee compensation of those same workers in the primary sector. We showed that by imputing a "salary" to a proprietor equal to the salary earned for equivalent work in the primary sector, nearly 95% of "proprietors' income" can be explained away, leaving the balance as returns to capital ownership.

The assumption in Equation 1 can be converted into Equation 2 as follows:

$$(2) \quad N^s = \left[N^t \left(\frac{L^i}{L^t} \right) - N^p \right] \lambda$$

where N^s = the estimate of secondary sector national income
L^i = L^{p+s}, the sum of secondary and primary labor force (Ch. 7)
N^t = total national income (National Income Accounts)
N^p = primary national income (Chapter 5)
λ = correction factor (see text)

All the variables on the right-hand side are known from either published data or data generated in previous chapters. The equation was estimated for 1967, and produced secondary national income of $149,065 million, somewhat less than the known target of $162,253 million. A correction factor of 1.09 was applied to insure that the series estimated using Equation 2 locked into the known 1967 secondary national income. Lambda can be dispensed without losing the relative change of secondary sector, since it is a constant. Hence, although the actual magnitudes may be subject to a ± 9% error, the relative magnitudes are correct over time.

The procedure in Equation 2 was applied against the time series on information workers, resulting in an estimate of secondary national income shown in column 1 of Table 9.8. The table also contains summaries of primary national income drawn from Chapter 5.

The Secondary Sector Over Time

The growth of the secondary sector is the growth of a bureaucratic society. We can see very clearly from Table 9.8 five stages of bureaucracy between 1929 and 1974, and the relationship between the bureaucracies and the primary information sector. This section is an exercise in historical conjecture,[4] and hopefully raises many more questions than it answers.

We open the story immediately before the Depression. The primary information sector accounts for 18% of national income, and the society as a whole is not yet encumbered by bureaucracy--some 13% of national income originates in the secondary factor. As the Depression develops, the secondary sector unravels and

TABLE 9.8:

TIME SERIES OF NATIONAL INCOME ORIGINATING IN THE SECONDARY AND PRIMARY INFORMATION SECTORS, 1929 - 1974

YEAR	($M, Current) SECONDARY NATIONAL INCOME (N^S)	N^S AS PERCENT OF TOTAL NATIONAL INCOME	N^S AS PERCENT OF PRIMARY NATIONAL INCOME	PRIMARY NATIONAL INCOME AS A PERCENT OF TOTAL NATIONAL INCOME[a]
1929	11,421	13.16	72.10	18.25
1930	10,273	13.63	72.18	18.87
1931	6,976	11.69	56.78	20.59
1932	3,830	8.95	38.96	22.97
1933	3,686	9.14	40.11	22.79
1934	5,468	11.07	52.79	20.96
1935	6,948	12.15	61.02	19.90
1936	7,800	12.00	60.07	19.97
1937	9,898	13.44	72.31	18.58
1938	7,905	11.73	58.42	20.08
1939	8,997	12.40	63.88	19.41
1940	10,810	13.32	72.04	18.49
1941	16,697	16.03	95.81	16.73
1942	24,709	18.05	115.73	15.59
1943	32,636	19.15	125.37	15.27
1944	35,063	19.20	120.56	15.92
1945	32,979	18.17	103.51	17.55
1946	33,839	18.58	104.13	17.84
1947	40,141	20.16	118.25	17.05
1948	47,723	21.13	125.65	16.81
1949	44,005	20.08	108.96	18.42
1950	51,163	21.07	116.14	18.14
1952	65,093	22.18	117.09	18.94
1954	67,775	22.20	107.67	20.61
1956	82,329	23.32	110.13	21.17
1958	85,555	23.07	100.77	22.89
1959	95,509	23.65	102.58	23.06
1960	99,314	23.75	100.38	23.67
1961	102,002	23.73	97.71	24.29
1963	119,385	24.67	100.41	24.56
1965	141,625	25.05	99.11	25.27
1967	162,253	24.75	93.28	26.53
1969	191,540	24.84	90.76	27.37
1970	197,180	24.51	87.19	28.11
1971	213,793	24.69	88.07	28.03
1972	239,058	24.99	89.77	27.83
1973	276,275	25.68	94.19	27.26
1974	289,761	24.44	85.81	28.47

N^S = secondary national income

[a] For total national income, see Table 5.2, the full time series in Appendix 5 (Vol. 8), and Table 9.9.

almost vanishes. By 1933, only 9% of national income is secondary, compared to a rise in the relative importance of the primary sector from 18% to 23% of total national income. While the primary sector seems to be fairly recession proof, or even mildly contracyclical, the secondary sector is the first economic luxury to hit the street. Overhead management and secretarial support is sliced out of corporations; state and local government bureaucrats unprotected by tenured positions are laid off; excess clerical fluff is squeezed out of proprietorships. The bureaucracy is downwardly elastic with output. During the period 1929-1933, the secondary sector shrank from 72% of the primary information size to 40%.

It could have receded farther except that the Federal Government began legislating and implementing a variety of national recovery programs. The new programs required planning, management, coordination, and clerical support--all elements of the secondary information sector. By 1934, as Federal programs were in full swing, the secondary sector turned around, climbing from 9% of national income up to 11%.

The next period, spanning years 1934-1940, was a time of adjustment and consolidation for both information sectors. The primary sector held between 19% and 20% of national income, which tripled during these years. The rate of growth of the primary sector, then, was just equal to the economy as a whole. The bureaucracies fared about the same, inching up from 11% of national income to about 13%. In current dollars, the output of the secondary sector rose from $5.5 billion to $10.8 billion. At the start of the period, the secondary sector was around half the size of the primary sector. By the end of the period, it was 72% the size of the primary sector, regaining its pre-Depression level. The second stage marked the mustering of both private and public bureaucratic impulses, which began to accelerate as the U.S. entered World War II.

The third period spans the war years, 1939-1946. The war brought a boom economy, with GNP increasing at a compound rate of 11% (3.6% constant). By 1939, the economy had regained its 1929 level of output, at around $205 billion (constant 1958) dollars, and the wartime economy was being geared up. Between 1939 and 1941, the bureaucracies jumped from 12% of national income to 16%, while the primary sector declined from 19% to 17%. As the war ensued, the private and public bureaucracies increased to 19% of national income, surpassing the primary sector for the first time. It was during the war that planning and coordinating information produced in support of noninformation activities was recognized as more important than the actual production of information goods and services for market exchange. Between 1943 and 1945, at the height of the war effort, the secondary sector grew 25% larger than the primary information sector.

With the war over and the armies returning to the private sector, the United States entered the fourth stage of bureaucratic development. Large organizations--and organization men--were accepted, cherished, and nurtured in the private sector. Corporations grew very rapidly, not only in output but in the sheer size of headquarters' staffs. Between 1946 and 1956, the national income originating in the secondary sector expanded at around $7 billion per year, exceeding the growth of the primary sector by a large margin. By the close of the fourth stage, the secondary sector accounted for almost one quarter of total national income.

The fifth and present stage (1958-1974) involves the computer and computer techniques. The manufacture and sale of new information machines and services advanced the size of the primary sector from 23% to nearly 29% of national income. The secondary sector held its own at between 23% and 25% of national income. While national income overall, and the primary information sector in particular, increased at a very rapid pace, the bureaucracies seemingly reached a steady state during this period. The secondary sector shrank relative to the primary sector, from a high of 125.65% the size of the primary (in 1948) to a low of only 85% the size of the primary sector by 1974. Two phenomena coincide here: (i) primary information industries are selling more goods and services to the secondary industries, and (ii) some secondary "quasi-industries" are spinning off and joining the primary sector. Much more can be made of these data, if a willing researcher wants to investigate them in detail.

Net Growth Over Time

Figure 9.1 and the associated data of Table 9.9 show a complete time series of primary and secondary components of national income.

FIGURE 9.1:

TIME SERIES OF NATIONAL INCOME ORIGINATING IN THE INFORMATION SECTORS

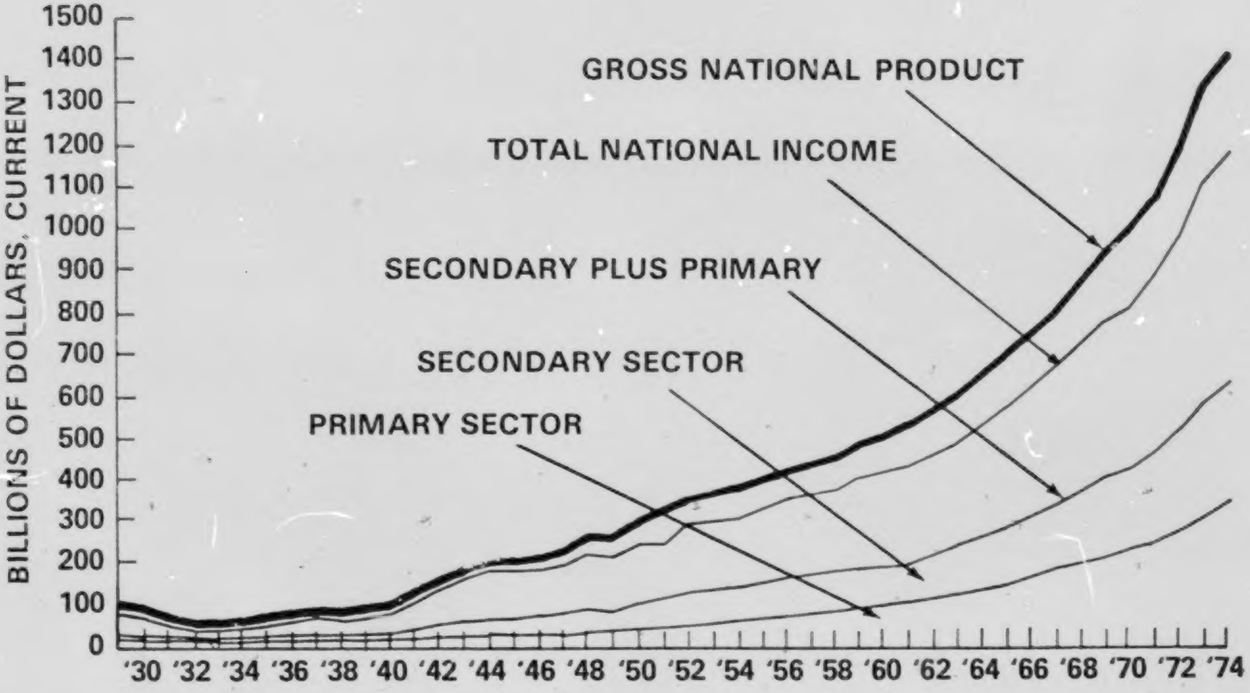


TABLE 9.9:

TIME SERIES OF NATIONAL INCOME ORIGINATING IN THE INFORMATION SECTORS 1929-1974

($ Billions, Current)

	THE INFORMATION SECTORS[a]				
YEAR	PRIMARY NATIONAL INCOME	SECONDARY NATIONAL INCOME	TOTAL INFORMATION INCOME $N^P + N^S$	TOTAL NATIONAL INCOME	GNP (IN BILLIONS)
1929	15,841	11,421	27,262	86,795	103.4
1930	14,232	10,273	24,505	75,382	90.7
1931	12,286	6,976	19,262	59,669	76.1
1932	9,831	3,830	13,661	42,785	58.3
1933	9,189	3,686	12,875	40,312	55.8
1934	10,385	5,468	15,853	49,415	65.3
1935	11,386	6,948	18,334	57,208	72.5
1936	12,985	7,800	20,785	65.013	82.7
1937	13,687	9,898	23,585	73,650	90.7
1938	13,582	7,905	21,437	67,372	85.0
1939	14,085	8,997	23,082	72,564	90.8
1940	15,005	10,810	25,815	81,124	100.0
1941	17,428	16,697	34,125	104,150	124.9
1942	21,350	24,709	46,059	136,923	158.3
1943	26,031	32,636	58,667	170,404	192.0
1944	29,083	35,063	64,164	182,601	210.5
1945	31.859	32,979	64,838	181,489	212.3
1946	32,498	33,839	66,337	182,101	209.6
1947	33,947	40,141	74,088	199,068	232.8
1948	37,982	47,723	85,705	225,860	259.1
1949	40,385	44,005	84,390	219,189	258.0
1950	44,055	51,163	95,218	242,826	286.2
1952	55,592	65,093	120,685	293,525	347.2
1954	62,947	67,775	130,772	305,238	366.3
1956	74,755	82,329	157,084	353,037	420.7
1958	84,902	85,555	170,457	370,807	448.9
1959	93,104	95,509	188,613	403,617	486.5
1960	98,935	99,314	198,249	417,970	506.0
1961	104,389	102,002	206,391	429,761	523.3
1963	118,899	119,385	238,284	484,026	594.7
1965	142,903	141,625	284,528	565,434	688.1
1967	173,935	162,253	336,188	655,617	796.3
1969	211,048	191,540	402,588	771,071	935.5
1970	226,160	197,180	423,340	804,425	982.4
1971	242,763	213,793	456,556	866,020	1063.4
1972	266,293	239,058	505,351	956,771	1171.1
1973	293,305	276,275	569,580	1,075,748	1306.3
1974	337,670	289,761	627,431	1,185,712	1406.9

---

[a] See Table 9.8 for percents; see also Table 12 in Appendix 9 (Vol. 8).

Table 9.10 shows the growth of the primary and secondary information sectors net of the general growth in national income. This table shows, on a yearly basis, where the two information sectors surpassed or were exceeded by growth in the overall economy.

The table is computed on current dollars only, since the necessary deflators for the primary and secondary sectors are not reliable for the entire time series. The first three columns of Table 9.10 show the difference between the primary and secondary national income growth rate and total national income. Positive numbers indicate that the sector grew faster than total national income. The table also shows a comparison of the primary and secondary sectors to GNP. To complete the comparison, current growth rates of both national income and GNP are shown as columns 7 and 8. (For example, in 1929-1930, the secondary sector grew at a net rate of 3.1% compared to national income, and decreased 9.2%.) The same data are displayed more vividly in Figure 9.2.

Between 1929 and 1947, the primary sector exceeded the overall national income growth rate in 23 periods, and lagged behind the overall economy 14 times. The secondary sector fared similarly, leading the economy 23 times and lagging during 14 periods. The primary and secondary sectors moved together as complements during 10 periods; and moved in opposite directions during 27 periods.

Components of the primary and the secondary sectors can be seen as substitutes, since they produce some services that are identical in nature. If they are substitutes, then the two sectors combined can be measured against national income. Column 1 of Table 9.10 shows that during 31 of 37 periods, the two information sectors combined grew faster than the overall economy. When these data are compared to GNP the general relationship is maintained.

TABLE 9.10: NET GROWTH OF THE TWO INFORMATION SECTORS COMPARED TO NATIONAL INCOME AND GNP 1929 - 1974[a]

Period	NATIONAL INCOME			GROSS NATIONAL PRODUCT			SIMPLE GROWTH RATES	
	Both Sectors % Annum	Primary Sector % Annum	Secondary Sector % Annum	Both Sectors % Annum	Primary Sector % Annum	Secondary Sector % Annum	% Total National Income	Gross National Product
1929 - 1930	3.0	3.0	3.1	2.2	2.1	2.2	-13.1	-12.3
1930 - 1931	-0.6	7.2	-11.2	-5.3	2.4	-16.0	-20.8	-16.1
1931 - 1932	-0.8	8.3	-16.8	-5.7	3.4	-21.7	-28.3	-23.4
1932 - 1933	0.0	0.3	- 0.6	-1.5	-1.2	- 2.1	- 5.8	- 4.3
1933 - 1934	0.5	-10.8	29.9	6.1	-5.2	35.5	22.6	17.0
1934 - 1935	-0.1	- 6.1	11.3	4.6	-1.4	16.0	15.8	11.0
1935 - 1936	-0.3	0.4	- 1.4	-0.7	0.0	- 1.8	13.6	14.1
1936 - 1937	0.2	- 7.9	13.6	3.8	-4.3	1[illegible].2	13.3	9.7
1937 - 1938	-0.6	7.4	-11.6	-2.8	5.2	-13.9	- 8.5	- 6.3
1938 - 1939	0.0	- 3.6	6.1	0.9	-2.7	7.0	7.7	6.8
1939 - 1940	0.0	- 5.3	8.4	1.7	-3.6	10.0	11.8	10.1
1940 - 1941	3.8	-12.2	26.1	7.3	-8.8	29.6	28.4	24.9
1941 - 1942	3.5	- 9.0	16.5	8.2	-4.2	21.2	31.5	26.7
1942 - 1943	2.9	- 2.5	7.6	6.1	0.6	10.8	24.5	21.3
1943 - 1944	2.2	4.6	0.3	-0.3	2.1	- 2.2	7.2	9.6
1944 - 1945	1.7	10.2	- 5.3	0.2	8.7	- 6.8	- 0.6	0.9
1945 - 1946	2.0	1.7	2.3	3.6	3.3	3.9	0.3	- 1.3
1946 - 1947	2.4	- 4.9	9.3	0.6	-6.6	7.6	9.3	11.1
1947 - 1948	2.2	- 1.6	5.4	4.4	0.6	7.6	13.5	11.3
1948 - 1949	1.5	9.3	- 4.7	-1.1	6.8	- 7.3	- 3.0	- 0.4
1949 - 1950	2.0	- 1.7	5.4	1.8	-1.8	5.2	10.8	10.9
1950 - 1952	0.3	5.3	- 4.0	-0.1	4.9	- 4.4	20.9	21.3
1952 - 1954	8.8	9.2	8.4	7.3	7.7	6.9	4.0	5.5
1954 - 1956	5.0	3.1	6.8	5.8	3.9	7.6	15.7	14.9
1956 - 1958	3.5	8.5	- 1.1	1.8	6.9	- 2.8	5.0	6.7
1958 - 1959	1.8	0.8	2.8	2.3	1.3	3.3	8.8	8.4
1959 - 1960	1.6	2.7	0.4	1.1	2.3	0.0	3.6	4.0
1960 - 1961	1.3	2.7	- 0.1	0.7	2.1	- 0.7	2.8	3.4
1961 - 1963	2.8	1.3	4.4	1.8	0.3	3.4	12.6	13.6
1963 - 1965	2.6	3.4	1.8	3.7	4.5	2.9	16.8	15.7
1965 - 1967	2.2	5.8	- 1.4	2.4	6.0	- 1.2	15.9	15.7
1967 - 1969	2.1	3.7	0.4	2.3	3.9	0.6	17.6	17.5
1969 - 1970	0.8	2.8	- 1.4	0.1	2.1	- 2.1	4.3	5.0
1970 - 1971	0.2	- 0.3	0.8	-0.4	-0.9	0.2	7.7	8.2
1971 - 1972	0.2	- 0.8	1.3	0.6	-0.4	1.7	10.5	10.1
1972 - 1973	0.3	- 2.3	3.1	1.2	-1.4	4.0	12.4	11.5
1973 - 1974	-0.1	4.9	- 5.3	2.5	7.4	- 2.8	10.2	7.7

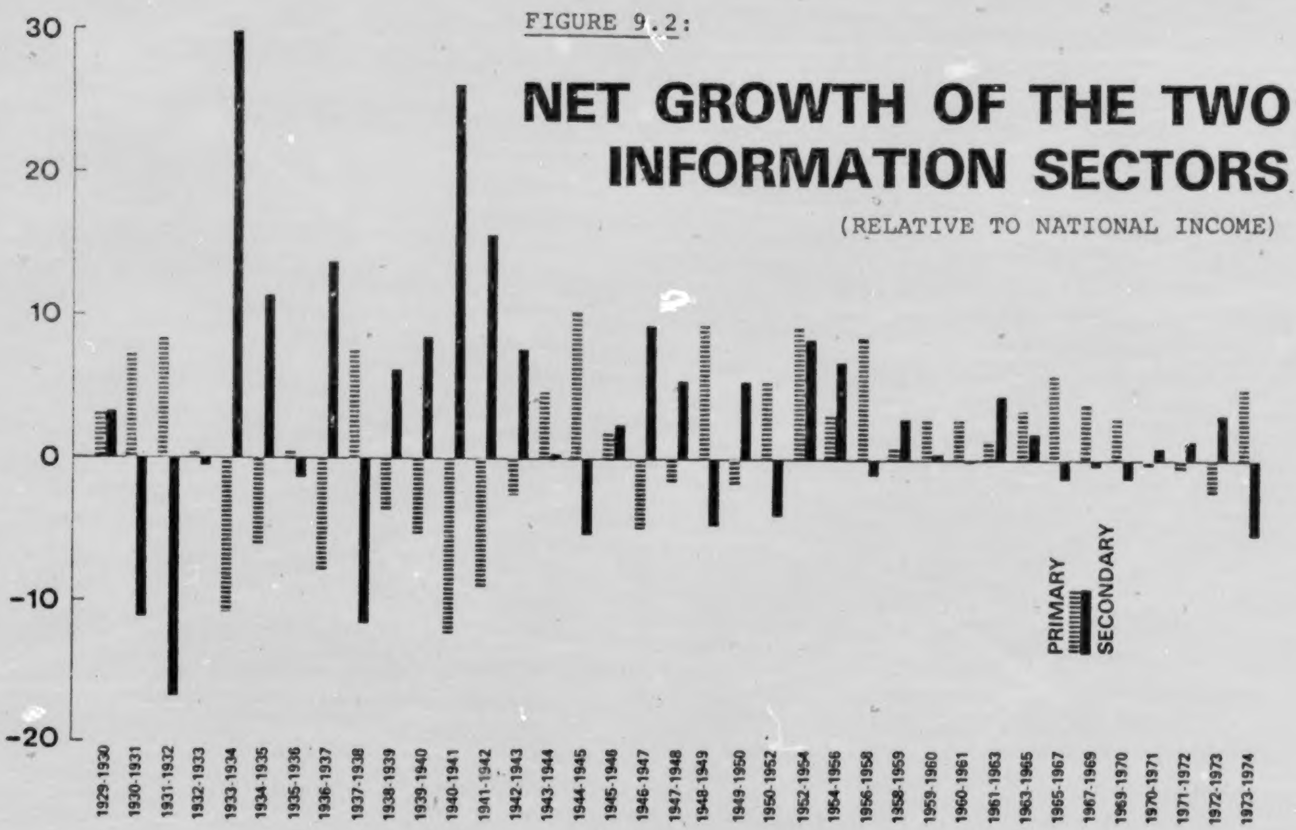
---

[a] All growth rates computed on current dollars, since accurate deflators for primary and secondary sectors have not been developed.

FIGURE 9.2:

NET GROWTH OF THE TWO INFORMATION SECTORS

(RELATIVE TO NATIONAL INCOME)



Information and Productivity

The relationship between information and productivity has been often broached, but never measured. In this section, I offer one index of productivity in the secondary information sector. The index is used to decompose the contribution of the secondary sector to the general rate of inflation. This section is but a cursory introduction which will hopefully be pursued by future researchers.

In thinking through the relationship between information and productivity, we shall borrow a useful concept from Egon Neuberger.[5] He suggests that an economic system can be divided into information and production subsystems. To simplify the model considerably, he further states that all goods and services are produced in the production subsystem. The information subsystem accounts for

> "...the collection, transmission, processing, storage, and retrieval and analysis of economic data, the communication of orders or other signals, and the feedback necessary for the evaluation of decisions taken as a result of signals [and] is a necessary input into every aspect of informational decision-making. The larger the number of participants in the economic process, the greater the division of labor, the more complex the technological processes, and the wider the assortment of goods and services an economic system produces, the more intensive the information process becomes." (pp. 132-133)

Like the secondary information sector, the information services described by Neuberger are not transacted in a market place as goods or services. Rather, they are produced and consumed within firms, or occur in some other nonmarket (household or government) planning and decision-making context. For Neuberger, the information and production subsystems interact in three ways:

(i) The Input Effect. In the first case, the information system competes with the production system for scarce resources such as skilled labor or venture capital. Hence, the total inputs available to the noninformational sectors of the economy are reduced by the amount that flows into the information sector. In a two-sector economy, the amount of resources flowing to each sector is determined by the relative marginal physical productivities of the capital and labor in each sector and the prices (or returns) to each factor in each sector. Equilibrium is defined by the unwillingness of any to flow from one sector to another. That is, the ratios of marginal physical products of each factor to the prices of each factor are equal in both sectors. In equilibrium, the resources consumed by the information sector will necessarily be denied to the rest of the economy. Without any other effects, this "loss" will result in a diminished output to the production sector of the economy.

(ii) The Qualitative Output Effect. The use of an information system is indispensable to an economy, and the qualitative effect captures one of the ways in which productivity is enhanced. Simply stated, the use of information results in translation of consumers' preferences or planners' preferences in a "mix closer to the optimal." Better communication within firms increases output by reducing internal uncertainty; better communication between consumers and firms results in a more desirable good or service being produced; better communication between consumers results in more market information being available, hence purchases that are more "satisfying." These are all qualitative effects, since the society as a whole does not produce "more" goods, but rather more desirable ends are achieved with the same resources.

(iii) The Quantitative Output Effect in the last and most commonly discussed case, the use of information is itself a resource which enters the production function as any other factor input. The use of the information resource also contributes to technical efficiency, hence increasing the productivity of labor and capital. The last assertion lends itself to empirical testing, for it is nothing more than a specification of a production function or a measure of "total factor productivity" as advanced by Jorgenson and Griliches,[6] Denison,[7] Kendrick,[8] and others.[9]

The "input effect" discussed by Neuberger is amenable to direct estimation using the data developed on the secondary information sector. Conceptually, "real output" of an economy can be seperated from "information overhead inputs." Equation 3 shows the relationship more precisely. An index of productivity, H_1, can be built by constructing a ratio of real output to information input.

$$(3) \quad H_1 = \frac{\widetilde{GNP}}{\widetilde{N^S}} = \frac{N^n + \left(N^p - N^p \left(\frac{N^s}{N^t} \right) \right) + d}{N^s + N^p \left(\frac{N^s}{N^t} \right)}$$

where, N^n = national income in the noninformation industries (employee compensation of noninformation workers plus profits, interest and rents)

N^p = national income in the primary information sector

N^s = national income in the secondary information sector

N^t = total national income

d = depreciation

The numerator, then, contains a modified version of GNP which captures only real output, including:

(i) national income originating in the purely noninformational sectors of the economy; PLUS

(ii) the national income in the primary information sector LESS an imputed cost of operating the bureaucracies within primary sector firms. (This imputation is derived from the overall economy's ratio of secondary information to total income. It is a global parameter which can obviously vary between industries. A refinement of Equation 3 should determine more precisely how large a portion of primary information industries' income is bureaucratic in origin); PLUS

(iii) depreciation taken on all equipment other than information machines used in the secondary sector.

The denominator contains three residual informational overhead components removed from GNP:

(i) the pure secondary information income; PLUS

(ii) the imputation of secondary-type income originating in the primary information industries; PLUS

(iii) depreciation on information machines used in a secondary activity.

This index was applied to the 1929-1974 national income data discussed previously. The results, shown in Table 9.ii, reveal a stunning relationship.

TABLE 9.11: PRODUCTIVITY AND INFORMATION OVERHEAD EXPENSE 1929-1974

Year	(1)	Year	(1)
1929	6.66	1948	3.65
1930	6.43	1949	3.95
1931	8.05	1950	3.73
1932	11.38	1952	3.88
1933	11.65	1954	3.52
1934	8.87	1956	3.22
1935	7.70	1958	3.27
1936	7.84	1959	3.14
1937	6.73	1960	3.12
1938	7.96	1961	3.13
1939	7.45	1963	3.00
1940	6.81	1965	2.88
1941	5.41	1967	2.88
1942	4.54	1969	2.83
1943	4.10	1970	2.89
1944	4.18	1971	2.88
1945	4.48	1972	2.83
1946	4.26	1973	2.72
1947	3.95	1974	2.78

(1). Ratio of real output (net of all informational overhead expenses) to total overhead expenses, i.e., units of output per units of secondary-type informational inputs.

In 1974, the economy squeezed $2.78 of market output from each $1.00 spent in informational overhead. In 1963, the bureaucracies were slightly more productive, generating $3.00 in output for every $1.00 spent for information. The farther back in time, the more output can be produced from the bureaucracies. During World War II, each bureaucrat, secretary, and scientist was generating, on the average, over $4.00 to every $1.00 in salary. In the late 1930's, the ratio was 5:1, 6:1, nearly reaching 8:1 in 1938. And at the height of the Depression, with every firm and every government agency cut to the bone, the economy survived for two years at the unmatched rate of $11 in output for every $1 in information overhead--four times higher than in 1974. This trend is graphically shown in Figure 9.3.

The time series shown in Table 9.11 can be interpreted as a measure of productivity. The units are current dollar ratios, and dimensionless. The table clearly shows that an increasing number of informational support activities are now consumed in producing every dollar of output. Equation 3 does not take into account productivity gains in the "real" sectors of the economy. General productivity increased during this period, meaning that the numerator was increasing at around 2% per year net of all other causes. The ratio in Table 9.11 is a "net" measure, since it ignores the overall productivity changes.

As industries become more information intensive, resources (and income) are shifted out of the numerator and into the denominator. However, if the increased use of information resources were fully matched by a compensating rise in real output, the index would remain flat over time.

A brief numerical example captures this relationship. Assume that at time 1, the productivity index H_1 is 4.0:

$$(4) \quad H_{t1} = \frac{\widetilde{GNP}}{\widetilde{N^S}} = \frac{8}{2} = 4.0$$

Total GNP is 10 units. Now, if the marginal physical productivity of information resources were to double, we might expect the denominator to double. This could happen in two ways:

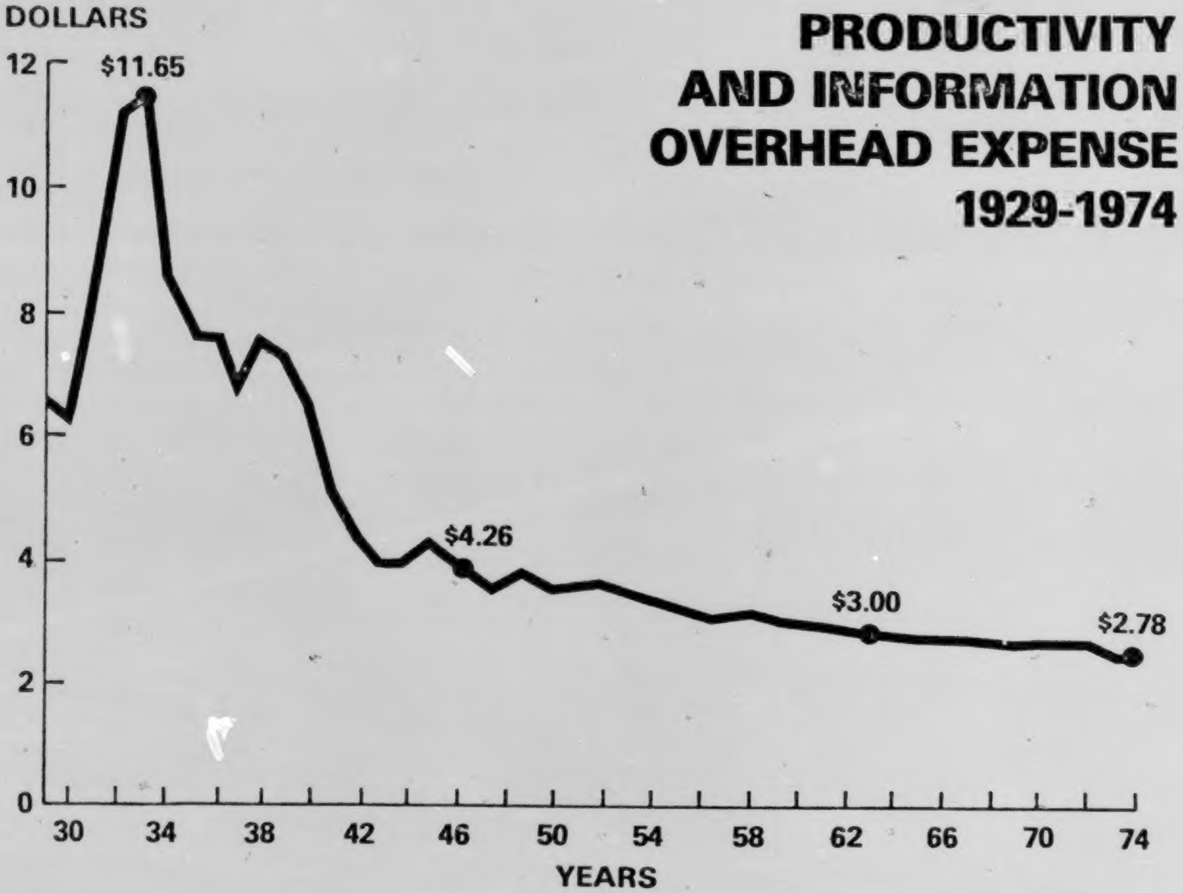
$$(5) \quad H_{t2} = \frac{6}{4} = 1.5$$

OR

$$(6) \quad H_{t2} = \frac{16}{4} = 4.0$$

FIGURE 9.3:

PRODUCTIVITY AND INFORMATION OVERHEAD EXPENSE 1929-1974



Equation 5 shows an uncompensated shift towards N^S. The denominator doubled, but GNP stayed the same (=10). Hence, the productivity index declined to 1.5.

Equation 6, by contrast, showed that the doubling of information resources preserved the original index of productivity at 4.0. The new GNP at t_2 is 20, and the input effect was fully compensated.

The data shown in Table 9.12 suggest that the example in Equation 5 has occurred. The almost monotonic drop can be interpreted as a loss in productivity of the secondary information activities; or, as an uncompensated rise in the amount of secondary information resources used to produce noninformation goods and services. This is a description of the economy as it changes its mix of information and noninformation resources. Equation 3 does not imply that the bureaucracies were 5 times as efficient in 1933 than in 1974. In 1933, the economy was in a disastrous condition, and very little coordination was needed. The 1974 economy is extremely complex, over 30 times as large as the 1933 economy (in national income terms), and is actively multinational. The planning and coordination costs of managing such complexity increase exponentially, while the information costs have increased linearly in the last 30 years. Also, no welfare implications are intended. Complexity and information intensiveness bring certain benefits which are not immediately apparent. For example, society may benefit from an active pharmaceutical testing and certification program. Although the informational overhead may increase, the costs might be justified on welfare grounds. The "quality" of our information environment may have improved *pari passu* with rising costs.

A small reprieve is shown in 1974, with a slight upturn from the 1973 low of 2.72 to 2.78--about a 2% gain for the year. However, the data are sufficiently untested that not too much can be said for such small differences. What is significant is the persistent trend over the last 40 years.

Secondary Productivity and Inflation

A set of deflators was constructed from the data shown in Table 9.11 (1972=100.00). With the assumption that firms were compelled to hire more managers and secretaries to perform the same quantity of tasks as the previous year, the output price of the secondary services increased as productivity dropped. This added cost was passed through in the form of higher market prices. If industries did not use pass-through pricing rules, then the following conclusions do not hold.

Table 9.12 links the productivity losses in the secondary sector with inflation in the overall economy. Column 1 shows the GNP deflator taken from the *Survey of Current Business*. Column 2 shows the deflator for the secondary information services. Both series are benchmarked on 1972=100.00.

TABLE 9.12: GNP DEFLATORS AND SECONDARY SECTOR DEFLATORS, 1946-1974

PERIOD	GNP[a] DEFLATOR d_t	SECONDARY[b] SECTOR DEFLATOR e_t
1946	43.9	66.5
1947	49.7	71.6
1948	53.1	77.6
1949	52.6	71.8
1950	53.6	75.8
1952	58.0	73.0
1954	59.7	80.5
1956	62.9	88.0
1958	66.1	86.6
1959	67.5	90.2
1960	68.7	90.8
1961	69.3	90.6
1963	71.6	94.4
1965	74.3	98.4
1967	79.0	98.4
1969	86.7	99.9
1970	91.4	98.0
1971	96.0	98.2
1972	100.0	100.0
1973	105.9	104.3
1974	116.2	101.9

[a] Source: Survey of Current Business, January 1976, Vol. 56, No. 1, Part II.

[b] From Table 9.11, the secondary deflator $e_t = \frac{x_{1972}}{x_t}$, $t = 1946 \ldots 1974$. These may be interpreted as deflators under the assumption that the ratio of "real" output to secondary output remained constant.

An estimate of the secondary sector's contribution to inflation can be estimated using Equation 7:

$$H = \left(d_{t+1} - d_t \right) - \frac{N^s_t}{GNP_t} \left(e_{t+1} - e_t \right) \tag{7}$$

where, $d_{t+1} - d_t$ is the general inflation in period t to t+1

$e_{t+1} - e_t$ is the inflation due to productivity loss (gain) in the secondary sector (difference between the two price deflators)

H is the rate of inflation. With no change in secondary productivity, H = the GNP deflator.

The difference between period 1 and period 2 inflation in the secondary sector is weighted by the share of secondary output to total output. This weighting assures that the contribution to inflation is kept proportional to the size of the secondary industries. Equation 7 is subject to the definitional vagaries introduced in Equation 3, since it cascades the possible errors in the ratio N^s/GNP. However, it is applied consistently over time, so that any errors are likely to be systematic.

Table 9.13 shows a decomposition of inflation into two parts. Column 1 shows inflation from all causes unrelated to information such as changes in the money supply, weather, price of natural resources, union wage demands, etc. Column 2 shows the price rises induced by productivity losses in the secondary factor. Column 3 returns us back to the GNP deflator for the period shown. Note that column 2 captures the rise in employee compensation to professional, clerical, and managerial workers above and beyond their contribution to output. Since the secondary sector is essentially all wages and salaries of information workers, this interpretation is quite sound. Productivity of professional, managerial, and clerical workers has apparently not kept pace with wages.

TABLE 9.13: INFLATION IN THE SECONDARY INFORMATION SECTOR, 1946-1974

(PERCENT)

Period	Inflation From All Exogenous Causes	Inflation from Productivity Losses (Gains) in Secondary Sector	Total[a] Inflation
1946 - 1947	5.0	0.8	5.8
1947 - 1948	2.4	1.0	3.4
1948 - 1949	0.5	-1.1	-0.5
1949 - 1950	0.4	0.7	1.0
1950 - 1952	4.9	-0.5	4.4
1952 - 1954	0.4	1.3	1.7
1954 - 1956	1.8	1.4	3.2
1956 - 1958	3.4	-0.3	3.2
1958 - 1959	0.8	0.7	1.5
1959 - 1960	1.0	0.1	1.2
1960 - 1961	0.6	0.0	0.6
1961 - 1963	1.6	0.6	2.3
1963 - 1965	1.9	0.8	2.7
1965 - 1967	4.7	0.0	4.7
1967 - 1969	7.4	0.3	7.7
1969 - 1970	5.0	-0.4	4.6
1970 - 1971	4.6	0.0	4.7
1971 - 1972	3.6	0.4	4.0
1972 - 1973	5.0	0.9	5.9
1973 - 1974	10.8	-0.5	10.3

[a] Differences in addition due to rounding error.

Source: *Survey of Current Business*, January 1976, Vol. 56., No. 1, Part II

In the 20 periods covered by Table 9.13, the secondary sector was deflationary 7 times. In 1946-47, about 14% of that year's inflation rate of 5.8% is explained by a productivity loss in the secondary factor. In 1947-48, fully 30% of the inflation (or 1.04%), is due to unrewarded expansion of the secondary sector. In no case did the secondary sector contribute more than 1.5% to the inflation rate. But even such modest amounts must be tempered against the awareness that nearly a million jobs hinge on each percentage point in the rate of inflation. The results are paradoxical. The bureaucracies offer employment to millions of workers. However, it is the inefficiency of expanding private and public bureaucracies that induces a rise in prices, resulting in lost jobs. As more and more information workers join the ranks of the "nonproductive," more and more noninformation jobs in agriculture, manufacturing, and services are lost since the economy cannot sustain them. The solution is not to dispense with the unneeded information workers, as they would merely join the ranks of the unemployed. The solution is to help them become more productive, hence generating employment and output in all sectors of the economy. And, to bring the paradox a full circle, the most likely source of increased productivity in the secondary sector is computer and communication technology--precisely the instruments that encouraged the growth of bureaucracies in the first place, and precisely the instruments that have been blamed with automation-induced unemployment.

The computer, it turns out, did not eliminate jobs--it created them. But it created jobs for information workers, who are not terribly productive. And now the computer is being sought as a remedy for productivity losses. A better marketing strategy could not have been invented!

FOOTNOTES

[1] See K.J. Arrow, "Vertical Integration and Communication," IMSSS Technical Report #145, Stanford University, October 1974; R. Wilson, "On the Efficient Scale of a Firm," IMSSS Working Paper #46, Stanford University, August 1974; and A.A. Alchian and H. Demsetz, "Production, Information Costs, and Economic Organization," *American Economic Review*, Vol. 62, December 1972. A considerable literature on "learning by doing" was started by K.J. Arrow "The Economic Implications of Learning by Doing," *Review of Economic Studies*, Vol. 29, 1962. See also J. Marschak, "Economics of Inquiring, Communicating, Deciding," *American Economic Review Proceedings*, Vol. 58, May 1968; W. Fellner, "Specific Interpretations of Learning by Doing," *Journal of Economic Theory*, No. 1, 1969; and S. Rosen, "Learning by Experience as Joint Production," *Quarterly Journal of Economics*, Vol. 86, August 1972.

[2] If a noninformation firm should decide to sell some of its excess data processing capability to other firms, the amount is treated by the Bureau of Economic Analysis as a transfer into the data processing industry. This insures that revenue figures for each industry reflect only the product of their primary industry affiliation. See Bureau of Economic Analysis, *Definitions and Conventions of the 1967 Input-Output Study*, October 1974.

[3] Joseph A. Schumpeter, *Capitalism, Socialism and Democracy*, 3rd edition, Harper & Row, New York, 1950. See especially Chapters 7 and 8 on the dynamics of oligopolies, and Chapter 12 on the role of innovation ("creative destruction") in an industry's life cycle.

[4] Blue Ribbon Defense Panel, "Report to the President and the Secretary of Defense on the Department of Defense," July 1970, Appendix E, pp. 44-45.

[5] What is needed is Volume 3 in the set by T.C. Cochran and T.B. Brewer, *Views of American Economic Growth: The Agricultural Era*, McGraw-Hill Book Company, New York, 1966; and *Views of American Economic Growth: The Industrial Era*, McGraw-Hill Book Company, New York, 1966.

[6] Egon Neuberger, "Libermanism, Computopia and Visible Hand: The Question of Informational Efficiency," *American Economic Review*, Vol. 56, No. 2, 1966, pp. 131-143.

[7] D. Jorgenson and Z. Griliches, "The Explanation of Productivity Change," *Survey of Current Business*, Vol. 52, No. 5, Part II, May 1972.

[8] Edward F. Denison, "Some Major Issues in Productivity Analysis," *Survey of Current Business*, Vol. 52, No. 5, Part II, May 1972.

[9] J.W. Kendrick, *Productivity Trends in the United States*, Princeton University Press, Princeton, 1961.

[10] See generally, V. Fuchs, *Production and Productivity in the Service Industries*, National Bureau of Economic Research, New York, 1969; and M. Porat, "Productivity and the Information Sector" in *Productivity and Information*, F. Bernstein and P. Polishuk (eds.), Engineering Foundation, 1976.

CHAPTER TEN

THE SECONDARY INPUT-OUTPUT MATRIX

The purpose of this chapter is to investigate the structure of the secondary information sector and show its relationship to the rest of the economy. The secondary information industries defined in Chapter 9 are built into a 190-order input-output matrix which also includes the primary and noninformation industries.

Inputs and Outputs of the Secondary Information Sector

The inputs of the secondary information industries are clear and measurable. First, all purchases of information goods and services from the primary sector are consumed by the secondary quasi-firms, not by the noninformation side of the firm. No attempt is made to distribute the goods and services among the quasi-firms; but in the aggregate, all information current account inputs are totally consumed by all the quasi-firms. Second, all patent rights, copyrights and royalties on intellectual property purchased from other secondary industries are measured as intermediate inputs. Third, all the employee compensation paid to information workers in noninformation industries appears as a value added input. Fourth, all capital consumption allowances taken on information machines and buildings enter the quasi-industries' value added accounts. This completely exhausts the input stream.

The outputs of the secondary industries are also clear and measurable. The outputs are divided into two types: intermediate and final. Final sales, such as royalty exports and sale of R&D to the Federal Government, were discussed in Chapter 9, and are a relatively minor source of income.

The secondary information industries produce two types of intermediate outputs, as shown in Table 10.1. First, the R&D quasi-firms occasionally produce and sell patents, rights, copyrights, and other forms of intellectual property to other secondary firms. Second, information services are sold on a fictitious account to the noninformation side of the firm.

Royalties

Patent and copyright sales reflect transfers between two R&D quasi-firms, usually within the same industry. Dupont may sell a process right to Monsanto; U.S. Steel may sell a patent right to Inland Steel. Firms purchase these information products in lieu of investing in their own R&D quasi-firm. That is, a manufacturer might face a decision whether to sink $10 million into an R&D project or whether to purchase rights from another firm. This decision is far from simple, since uncertainty regarding the product (R&D), its appropriability and its profitability are very high. Most firms, especially those specializing in consumer goods, first perform extensive market research before embarking on a product development. In some cases, however, it is not feasible to wait until a market has been discovered before developing a product. And sometimes markets are clearly established, but are inaccessible because some other firm holds the entry-barring patent.

Institutional issues may impinge on markets in peculiar ways. For example, a firm may decide to sell patent licenses not for profit-maximizing reasons in the strict sense (i.e., that the flow of revenues from the sale of the patent exceeds the flow of monopoly rent less the expected revenue from selling the patent). Rather, patent rights may be sold off as a way of averting a likely antitrust action on the part of a would-be entrant. Or, firms may purchase patent rights simply to build their expertise in a competitor's technology only with the intention of leapfrogging the competitor who sold them the patent. Or, a firm may purchase a patent right as insurance against another firm's entry into the market, again with no intention of itself actually entering. For these reasons, quasi-firms may choose to purchase intellectual property. In the input-output matrix, this transaction is recorded as an inter-firm but intra-industry flow of royalties (see Table 10.1).

Information Services

The major intermediate outputs of the quasi-industries are the multitude of information services sold to the noninformation side of the firm. The problem is to define the output price of these services, and to create an account on which they are sold.

Recalling the discussion in Chapter 9, we know with certainty the input costs of the secondary information industries. If these firms were to relocate in the primary sector, their total revenues (TR^P) and profits (π) would be as shown in Equations 1 and 2.

$$(1)\quad TR^P = p \cdot q$$

$$(2)\quad \pi^P = p \cdot q - TC$$

The total costs (TC^P) of the primary firm are,

Equation 3 is a function of some known Q, which has a precise meaning in the primary sector. For example, if the accounting quasi-firm were to migrate into the primary sector, it would compute its TC, and produce a schedule of prices for each service (Q).

$$(3)\quad TC + = w.L\,(Q) + r.K\,(Q) + b \cdot (Q) + c \qquad \text{where,}$$

w.L is total employee compensation; r.K is payments for capital services; b is the variable current account input; and c is the fixed cost of production.

We assume that the quasi-firms earn zero profit; that is, their total revenues just cover their total costs. From Equation 2 we know that total costs just equal price times quantity in the secondary firms. Their profits, total cost, and total revenues can be written as follows,

$$(4)\quad \pi^{s} = 0$$

$$(5)\quad TC = p \,.\, q$$

$$(6)\quad TR^{s} = p \,.\, q = w.L\,(Q) + r.K\,(Q) + b\,(Q) + c$$

Even though the secondary firms do not maintain explicit accounts of their prices and quantities sold, Equation 6 shows that a fictitious account can indeed be developed and measured precisely. If the quasi-firms are assumed to compete with primary sector firms offering the same service, their price schedule cannot vary too much from primary sector prices. Secondary firms purchase their labor and capital factors of production on competitive markets, and are price takers on the input side. On the output side they have more discretion in their implicit pricing. Their constraint in setting output prices comes only from the total market price for the enterprise's goods. Call these shadow prices and set them equal, $p^{p} = p^{s}$; we see that there must also exist a known quantity, q^{s}, if the identify in Equation 6 holds.

Hence, the output price and quantity of the secondary information sector has a well-defined meaning, and is directly measurable from data. The total output of the secondary sector is defined simply as the sum of employee compensation, capital consumption allowances, and intermediate purchases of goods and services. (The fixed cost, b, does not enter the calculation since it vanishes when we take the partial derivative of TR with respect to q.) These information services can be sold to the noninformation side of the firm as if they were products sold in primary markets.

There is some reason to assume that the output prices, p^{s}, are somewhat higher than those produced in the market sector. First, the primary sector firms are in a competitive setting, with clear (π) measures of performance. The implicit profits generated by secondary firms are buried in the enterprise's total profits, and hence cannot serve as a productivity signal. Second, bureaucracies tend to act as monopolists--or more correctly--as the stronger half of a duopoly or a bilateral monopoly. The manufacturing arm of an enterprise is a captive consumer of bureaucratic information sales. Niskanen[1] states the expected impact on prices as follows:

> "A [multiservice] bureau has a strong incentive to be the monopoly supplier of all services which are substitutes.... This leads to a larger budget than the sum of separate bureaus supplying the same or substitute service." (p. 111)

Hence, using the sum of factor costs as a proxy for a secondary bureaucracy's output prices tends to undervalue the information services by the ratio of competitive prices to "bureau" or monopoly prices.[2]

Table 10.1 shows a summary of the intermediate outputs of the secondary information industries. Column 1 shows the intra-industry sales of royalties; and column 2 shows the intra-firm sales of secondary information services.

BUILDING THE SECONDARY MATRIX

We now have all the information necessary to build an input-output matrix of the secondary information sector. We start with the basic primary sector matrix shown in a 2-by-2 order.

Figure 10.1 shows the simple structure of a two-sector economy. Cell a_{11} contains the inter-industry transactions between the 26 primary information industries. Cell a_{12} shows the primary industries' sales to noninformation industries. Cell a_{21} shows the primary sector purchases from the noninformation industries. And cell a_{22} shows the inter-industry transactions between the 82 noninformation industries. Associated final demand and value added are completely locked into the consolidated accounts of the primary sector.

FIGURE 10.1: INPUT-OUTPUT SCHEMATIC DIAGRAM SHOWING THE PRIMARY INFORMATION SECTOR

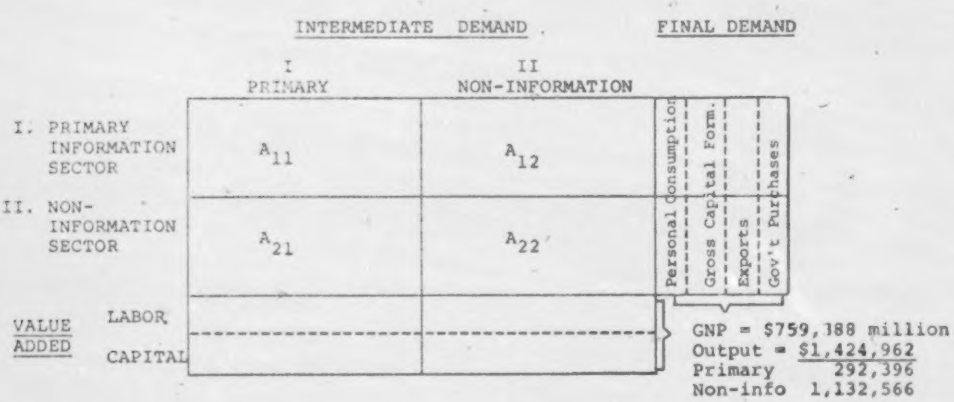

INTERMEDIATE DEMAND
FINAL DEMAND
I
PRIMARY
II
NON-INFORMATION
I. PRIMARY INFORMATION SECTOR
II. NON-INFORMATION SECTOR
A_{11}
A_{12}
A_{21}
A_{22}
Personal Consumption
Gross Capital Form.
Exports
Gov't Purchases
VALUE ADDED
LABOR
CAPITAL
GNP = $759,388 million
Output = $1,424,962
Primary 292,396
Non-info 1,132,566

TABLE 10.1: OUTPUTS OF THE SECONDARY INFORMATION INDUSTRIES

($ Millions, 1967)

NON-INFORMATION INDUSTRIES IO# NAME	INTERMEDIATE DEMAND INTRA-INDUSTRY ROYALTIES SALES	INTERMEDIATE DEMAND INTRA-FIRM SALES OF INTO SERVICES	FINAL DEMAND ROYALTY EXPORTS	FINAL DEMAND FEDERAL PURCHASES OF R&D
Total Private Sector	616	227,167	1,586	7,119
1. Livestock & livestock products	0	896	0	0
2. Other agriculture products	0	2,260	0	0
3. Forestry and fishery products	0	90	0	0
4. Argiculture, forestry, fishery svcs	2	332	0	0
5. Iron and feroalloy ores mining	0	220	8	0
6. Nonferrous metal ores mining	0	207	2	2
7. Coal mining	0	381	1	0
8. Crude petroleum & natural gas	0	2,124	2	0
9. Stone & clay mining & quarrying	0	391	0	0
10. Chemical & fertilizer mineral mining	0	125	0	0
11. New construction, net	0	14,956	13	191
12. Maintenance & repair construction, net	0	4,157	0	0
13. Ordnance and accessories	2	3,784	0	3,329
14. Food and kindred products	29	10,503	84	11
15. Tobacco manufacturers	0	724	3	0
16. Broad & narrow fabrics, yarn & thread mil	0	1,506	2	2
17. Misc textile goods & floor coverings	13	501	0	0
18. Apparel	19	3,140	1	0
19. Misc fabricated textile produots	1	505	0	0
20. Lumber & wood products, exc containers,net	4	1,475	0	0
21. Wooden containers	0	74	0	0
22. Household furniture	0	853	0	5
23. Other furniture & fixtures, net	0	334	0	0
24. Paper & allied products exc containers	10	3,080	22	1
25. Paperboard containers and boxes	1	1,190	1	0
26. Printing and publishing	1	1,067	0	0
27. Chemicals & selected chemical prod, net	83	3,558	101	121
28. Plastics & synthetic materials	17	1,359	39	52
29. Drugs,cleaning&toilet preparations	66	4,040	26	8
30. Paints & allied products	3	597	3	1
31. Petroleum refining & related industries	72	2,901	154	10
32. Rubber and miscellaneous plastics prods	13	2,467	14	4
33. Leather tanning & ind leather products	0	111	1	0
34. Footwear & other leather products	2	678	0	0
35. Glass & glass products	10	797	10	0
36. Stone & clay products	9	2,094	13	7
37. Primary iron & steel manufacturing	9	4,445	9	1
38. Primary nonferrous metal mfg.	9	2,072	11	17
39. Metal containers	2	541	1	3
40. Heating,plumbing&structural metal prods	9	2,196	9	25
41. Stampings, screw machine prods & bolts	4	1,578	9	18
42. Other fabricated metal products	6	2,179	15	10
43. Engines & turbines	3	616	10	7
44. Farm machinery & equipment	4	835	11	4
45. Construction, mining & oil field equip	10	1,157	34	5
46. Materials handling mach & equipment	4	525	3	14
47. Metalworking mach & equipment	8	1,905	12	22
48. Special ind mach & equipment, net	16	1,094	17	6
49. General ind mach & equipment	11	1,661	17	15
50. Machine shop products	1	980	2	5
52. Service industry machines	3	904	9	1
53. Elec ind equip & apparatus, net	20	2,197	13	179
54. Household appliances	9	1,196	5	3
55. Elec lighting & wiring equip	1	890	6	1
58. Misc electrical mach, net	3	670	5	8
59. Motor vehicles & equipment	34	4,620	55	33
60. Aircraft and parts	12	7,304	44	2,653
61. Other transportation equipment	8	1,227	5	4
62. Scientific & controlling instruments	1	517	5	10
63. Optical, ophthalmic & photo equip, net	0	125	0	2
64. Misc manufacturing, net	4	1,748	12	3
65. Transportating & warehousing	0	11,316	8	2
68. Elec. gas, water & sanitary svcs	2	3,401	30	1
69. Wholesale & retail trade, net	51	58,350	92	0
70. Finance & insurance, net	4	843	0	0
71. Real estate and rental, net	0	9,435	348	0
72. Hotels; personal & rep svcs exc auto,net	8	2,879	3	7
73. Business services, net	3	7,891	278	172
75. Automobile repair & services	0	2,294	0	0
76. Amusements, net	0	1,313	9	0
77. Medical,educ'l svcs &nonprofit orgns.	0	8,832	0	110
78. Federal govt enterprises, net	0	1,585	0	0
79. State & local govt enterprises	0	2,026	0	0
80. Imports	0	0	0	34
81. Business travel, entertain & gifts	0	343	0	0
82. Office supplies	0	0	0	0

Figure 10.2 shows the simple structure of a three-sector economy--the primary sector, the secondary sector, and the noninformation sector. The major difference between the two tables is that the noninformation industries of Table 10.1 have been torn apart. The noninformation portion now resides as sector III; and the information portion is shown as sector II. For each industry in the secondary sector (j=1...82), there is a corresponding "other half" in the noninformation sector (k=1...82).

Cell a_{11} contains the same inter-industry transactions between the primary information industries, as shown in Figure 10.1. The cell is completely unchanged.

Cell a_{12} shows the primary information goods and services sold to the secondary information industries. It contains the same information as cell a_{12} in the 2-by-2 table. These current account sales represent the "cost of goods" sold by the secondary industries, and enter the firm's cost functions.

Cell a_{13} is zero by definition, since the noninformation side of the firm cannot purchase any information resources, from outside the firm.

Cell a_{21} is zero by assumption, although it could contain some transactions. The output of the secondary industries includes a variety of royalty-type payments. However, we cannot determine how many payments were made across industry lines. Therefore, this cell was given a zero value.

Cell a_{22} shows the transactions in royalty-type payments. By assumption, all such transactions occur with a given industry; hence, all positive values reside along the main diagonal. The contents of the main diagonal are given in Table 10.1.

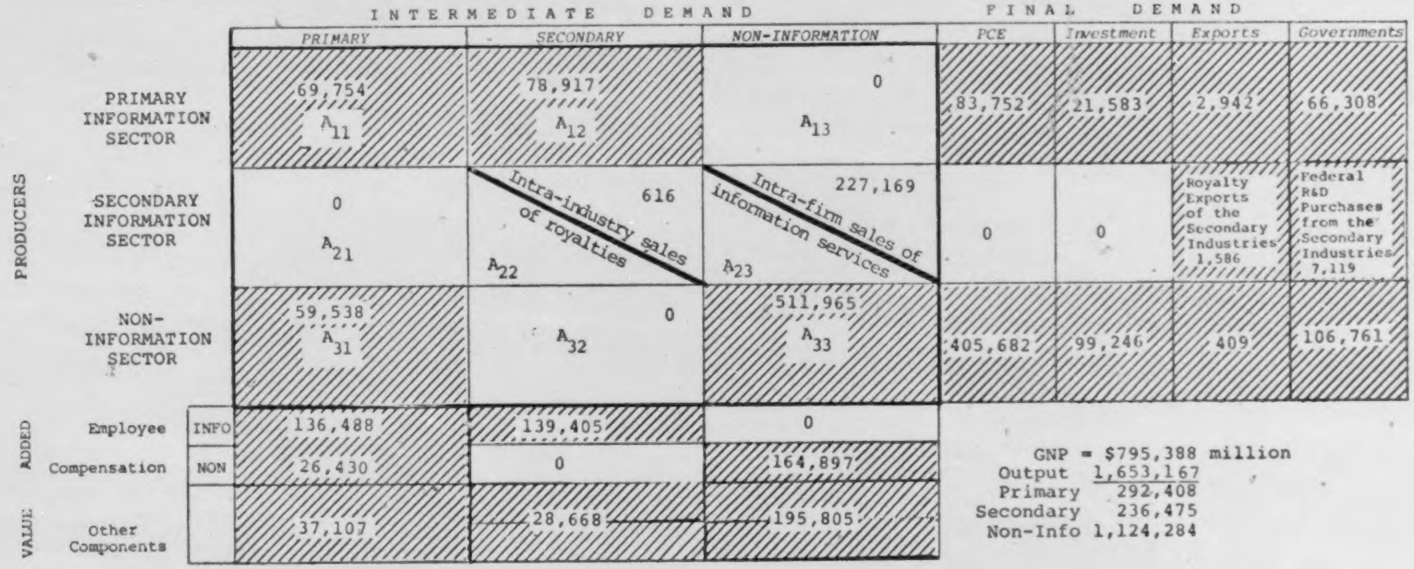
Cell a_{23} shows the intra-firm sales of secondary information services. The output price of these services is given in Equation 1; and the total revenue is shown in Table 10.1. The transactions are shown along the main diagonal since sales occur entirely between two sides of a firm. They are entirely intra-industry by definition.

Cell a_{31} shows the noninformation goods and services sold to the primary sector industries (e.g., sheet metal products to a computer manufacturer). This cell contains the same information as a_{21} of the 2-by-2 table.

Cell a_{32} is zero by definition, since the information quasi-industries have no use for noninformation goods and services.

Cell a_{33} contains all the inter-industry transactions in noninformation goods and services. It is the heart of the

FIGURE 10.2: INPUT-OUTPUT SCHEMATIC DIAGRAM SHOWING THE SECONDARY INFORMATION SECTOR



			INTERMEDIATE DEMAND			FINAL DEMAND			
			PRIMARY	SECONDARY	NON-INFORMATION	PCE	Investment	Exports	Governments
PRODUCERS	PRIMARY INFORMATION SECTOR		69,754 A_{11}	78,917 A_{12}	0 A_{13}	83,752	21,583	2,942	66,308
	SECONDARY INFORMATION SECTOR		0 A_{21}	616 Intra-industry sales of royalties A_{22}	227,169 Intra-firm sales of information services A_{23}	0	0	Royalty Exports of the Secondary Industries 1,586	Federal R&D Purchases from the Secondary Industries 7,119
	NON-INFORMATION SECTOR		59,538 A_{31}	0 A_{32}	511,965 A_{33}	405,682	99,246	409	106,761
VALUE ADDED	Employee Compensation	INFO	136,488	139,405	0				
		NON	26,430	0	164,897				
	Other Components		37,107	28,668	195,805				

GNP = $795,388 million
Output 1,653,167
Primary 292,408
Secondary 236,475
Non-Info 1,124,284

▨ Indicates that the cell contains a transaction value.

⧅ Indicates a main diagonal entry.

noninformation economy, as cell a_{11} is the heart of the information economy.

The value-added components of the primary information sector are exactly as shown in Figure 10.1 and reported in Chapter 4. The value-added components of the secondary sector are exactly as reported in Table 1 of Appendix 9 (Vol. 8). The value added of the noninformation sector is simply the residual.

The final sales of the primary sector are unchanged from the 2-by-2 matrix. The final sales of the secondary sector comprise only royalty exports and Federal R&D purchases, as shown in Table 10.1. The final demand sales of the noninformation sector is the difference between the original noninformation final demand (in Figure 10.1) and the components that were allocated to secondary final demand.

Impact on the Accounts

Total GNP is unchanged when we move from the 2-by-2 table to the 3-by-3 table. However, total output has increased by the amount of the fictitious intermediate sale of information services shown in cell a_{23}. Increasing the economy's output in this manner in no way affects the interpretation of GNP, since all intermediate transactions are netted out of GNP calculations. Also, total value added has simply been reallocated between two sectors; no new value added is implied or measured. The only impact that could cause some confusion is that the total output/labor and output/capital ratios for the secondary and noninformation industries have changed. When performing impact studies with the secondary matrix, adjusted ratios should be used.

Demand for Secondary Information Services

The secondary transactions matrix was built at the 190 order, including the original 26 primary information industries, 82 secondary information industries, and 82 noninformation industries. A technology matrix was then produced and inverted.

The secondary matrix begins to indicate the pervasive role of information in the production of noninformation goods and services. As we showed in Chapter 9, every industry supports a sizable information resource to design, produce and market its wares. Intuitively, every demand for a noninformation good or service generates a sequence of information activities. At the margin, part of the consumer's price pays for such things as point-of-purchase information exchange, credit card verification, billing and invoice handling, and internal inventory reports. On average, part of the output price pays for next year's R&D, product design, last year's litigation, government paper flows, meetings and meeting rooms.

The relationship between the noninformation and the secondary sector is technically fixed in the I-O matrix. In this section, we shall use the matrix to unravel the information costs generated by every purchase of a noninformation good or service.

Noninformation goods come jointly with information. Markets are set up to buy noninformation goods explicitly, even though there is a tacit recognition by both buyer and seller that the information embedded within the good has value, and affects the output price. But pure markets for information are quite rare, and for a variety of reasons information "products" are not sold as such, but are instead embodied in a hard good.

Consider a $1.00 purchase of gasoline. The historical costs of producing that $1.00 good may be broken into the following components (illustrative only):

TABLE 10.2: HYPOTHETICAL VARIABLE COSTS OF PRODUCING A NON-INFORMATION GOOD

	($ OF VARIABLE COST)	
COMPONENTS OF PRODUCTION	INFORMATION ACTIVITY	NON-INFORMATION ACTIVITY
Oil royalty rights		.10
Exploration	.10	
Drilling		.23
Shipping crude		.14
Refining		.10
Distribution to retail outlets		.13
General management of all components	.20	
Total	.30	.70

It is possible to conceive of a separate "exploration" industry that sells its services to the petroleum industry. This firm would engage in various informational tasks--making maps, performing seismographic tests, testing core samples, and so on. Its output is strictly an information product--an assessment of the present value of a prospective investment, with instructions on where and how deep to drill. It does nothing in a production sense.

When a final consumer purchases $1.00 of gasoline, he forces an indirect requirement for 10 cents' worth of exploration services. In an economy where all exploration services were divorced from the rest of the firm, this would result in an inter-industry transaction. Firms do not literally purchase 10 cents worth of exploration for every $1.00 of sale since oil discoveries come in nondivisible units, whereas crude oil flows continuously. Firms can "batch" their exploration activities in an anticipation of a smooth (continuous) flow. However in the long run, consumption of oil forces a requirement for an information service. Oil and knowledge are sold jointly in this sense, although the consumer only sees one price at the retail level.

The second order indirect effect is classic, and reveals the motivation for building the secondary matrix. Returning for a moment to an industry structure where the exploration firm is independent, a first round indirect requirement for exploration services leads to a second round requirement for a variety of information goods and services which form the inputs of the exploration firm. Computers, computer time, instrumentation, testing and laboratory equipment, map production services, and other related industries all receive indirect demands. Now, what if the technology of exploration should change but the rest of the petroleum industry remains the same? For example, exploration may take on deep-sea activities in greater proportion to total activities; hence its purchases of oceanic equipment and services will increase. By using the secondary matrix, this technical change can be readily modeled, and the new impacts measured.

Another example of joint production occurs in high technology electronics. Large scale integration (LSI) is a technique that squeezes tens of thousands of transistors onto miniature size chips. The process requires very few natural resources--a truckful of sand is about enough to produce all the LSI for one year's worth of computer logic manufacturing. But LSI requires a tremendous amount of initial design, development, debugging, acquisition of knowledge through "learning by doing," and quality control. Once the process is stable, the LSI component is inexpensive to produce. A $10 component may carry $9.00 of information embodied in the hard good, and about $1.00 of actual manufacturing.

A third example of joint production is in machine tools. A complicated tool, say a numerically controlled drill, contains a large component of design and programming information. A user purchases one tool over another because it is more productive. That is, the price of the tool allows the owner to do more with less time or labor. A high initial price for the embedded information is recouped by lower operating costs.

The central notion of automation and cybernetics is the replacement of human knowledge and skills by an information component or system embedded within a noninformation good. Automation can be explicitly translated into a technology. For example, if a machine manufacturer decided to build a new line of automatic machines, his input stream would change. He would purchase computers or computer components, hire programmers, build R&D labs, and so on. Conversely, if an industry began to automate, its input stream would change. These changes can all be modeled into the secondary matrix.

Another application of the secondary matrix is in modeling overhead costs of an industry. One of the Achilles' heels of the modern corporation is the massive inability to ascribe adequate productivity measurements or controls on its own internal bureaucracy. Recent innovations in computer processing and telecommunications have not yet proven effective in reducing the cost of managing and information processing. However, by anticipating improvements in this type of technology, selected secondary industries can be modeled to reflect changes in their inputs. For example, a noninformation industry with extensive commitment to computer communications, teleconferencing, and office automation has a completely different secondary information industry compared to that of a conventional industry. Also, various combinations of information labor and capital (e.g., one operator plus word processing machine less two typists and two typewriters) can be modeled and the changed requirements for primary sector industries derived.

Estimating Generated Demand for Secondary Information Services

The secondary information matrix gives us a direct way of measuring the secondary information requirements "forced" by a purchase of a noninformation good.

Equation 7 below illustrates a three sector system showing the primary, secondary and noninformation sectors (see Figure 10.2). The coefficients inside the square matrix (c_{ij}) are the inverse of the A matrix, showing the total output requirement per dollar of delivery to final demand. The D's are the final demands for each sector's output; and the X's are the total outputs for the three sectors.

All zero cells follow the assumptions discussed previously. In fact, when the transactions table is inverted, all zero cells take on very small positive values. (See Appendix 10 (Vols. 4, 5) for the 190 order A matrix and its inverse.) Also, even though the final demand for the secondary sector services exists, we shall call it zero for illustrative purposes.

$$(7) \quad \begin{bmatrix} c_{11} & c_{12} & 0 \\ 0 & c_{22} & c_{23} \\ c_{31} & 0 & c_{33} \end{bmatrix} \cdot \begin{bmatrix} D_1 \\ 0 \\ D_3 \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$

Carrying out the matrix multiplication shown in Equation 7, we immediately see that the secondary information sector has a positive output, X_2, even though its final demand is zero.

$$\begin{aligned} X_1 &= c_{11}D_1 + 0 + 0 \\ X_2 &= 0 + 0 + c_{23}D_3 \qquad (8) \\ X_3 &= c_{31}D_1 + 0 + c_{33}D_3 \end{aligned}$$

When a final-demand sector (e.g., personal consumption) buys a noninformation good (e.g., prescription drugs), a requirement will be generated by the noninformation side of the pharmaceutical firm for a variety of information services--R&D, testing, advertising, and so forth. The entire noninformation sector will generate a demand equal to $c_{33}D_3$.

This formula allows us to measure the generated total output of each secondary information industry. An interesting statistic showing the relationship between noninformation final demand and secondary information output is simply c_{23}, since

$$h_1 = c_{23} = \frac{c_{23}D_3}{D_3} \qquad (9)$$

The secondary matrix uses ten final demand sectors (D_{3j}, $j = 1...10$). We can derive secondary output generated by each of the ten final-demand factors (See Appendix 10 (Vol. 3)). We can also determine the component of secondary information, h_1, generated by a $1.00 purchase of every noninformation consumer good. Table 10.3 shows the statistic for a selection of common consumer goods and services. Column 1 shows the secondary output generated by personal consumption ($c_{23}D_3$); column 2 shows the personal consumption expenditures (D_3); and column 3 shows the statistic h_1, which is interpreted as the "total information component embedded in the price of a noninformation good or service."

TABLE 10.3:

TOTAL SECONDARY INFORMATION REQUIREMENTS GENERATED BY PERSONAL CONSUMPTION (PCE) OF NON-INFORMATION GOODS AND SERVICES

($ Millions, 1967)

SELECTED NON-INFO INDS	SECONDARY OUTPUT GENERATED BY PCE	TOTAL PCE FOR GOOD OR SERVICE	INFORMATION REQUIREMENT AS % OF OUTPUT PRICE
Total Non-Info PCE	139,225	394,856	35.3
Subtotal PCE	87,371	268,188	32.6
Goods	27,264	135,125	20.2
14 Food & kindred products	9,682	60,974	15.9
15 Tobacco manufacturers	624	5,270	11.8
18 Apparel	2,986	16,246	18.4
19 Misc textile products[a]	391	1,983	19.7
22 Household furniture	683	2,269	30.1
29 Drug,clean,toilet preps	3,422	7,293	46.9
31 Petroleum refining & rel[b]	2,047	10,194	20.1
34 Footwear & leather prods	657	3,659	18.0
54 Household appliances[c]	919	3,538	26.0
59 Motor vehicles & equip	2,615	15,822	16.5
61 Other transport equip[d]	248	1,078	23.0
63 Optical,opthalmic equip[e]	104	317	32.8
64 Misc mfrg (non-durable)[f]	1,383	4,213	32.8
Services	60,107	133,063	45.2
65 Transport & services[g]	6,461	11,396	56.7
68 Electric, gas, water,	2,626	13,935	18.8
69 Wholesale & retail trade[h]	47,853	95,836	49.9
75 Automobile repair	1,926	8,069	24.0
76 Amusements (non-info)[i]	1,241	3,827	32.4

---

[a] Includes draperies and curtains.

[b] Includes gasoline, kerosene, & heating fuel etc.

[c] Includes cooking, refrigerating, laundry equipment, vacuum cleaners, sewing machines, electric housewares, etc.

[d] Includes motorcycles, bicycles, trailer coaches.

[e] Includes opthalmic goods only; photographic equipment appears in the primary information sector.

[f] Includes jewelery, silverware, musical instruments, games, toys, sporting goods, brooms and miscellaneous consumer goods.

[g] Includes airline, train, railroad, bus and related transportation services.

[h] Includes the trade margins on the sale of non-information goods only.

[i] Includes all amusements except motion pictures and theater.

In 1967, around 35 cents of every consumer dollar paid for a variety of information services associated with inventing, designing, planning, and marketing the product. The other 65 cents paid for all the noninformational activities, such as the materials, machines, energy, transportation, warehousing, and so on. (For our representative sample, the ratio was 33 cents per dollar for information.) Tobacco manufacturers embedded the least information in a dollar purchase, at 11.8 cents. The informational content of food and kindred products was 15.9 cents per dollar. Apparel showed 18.4 cents worth of secondary information per dollar. Drugs and cleaning and toilet preparations embedded 46.9 cents of information per dollar. Note that these ratios are in producer's prices, not counting the markups imposed by the retail and wholesale trade. The 47 cents in this case paid for the extensive R&D, marketing studies, and direct advertising placed by firms such as Proctor and Gamble and Lever Brothers.

The informational costs associated with retail and wholesale trade are shown in Industry #69, and amount to 49.9 cents per dollar. If we assume that the trade margin is ordinarily 100%, a consumer buying a $2.00 tube of toothpaste pays the following hidden prices:

TABLE 10.4: INFORMATION CONTENT OF A $2.00 PHARMACEUTICAL PRODUCT

		SECONDARY INFORMATION COMPONENT	NON-INFORMATION COMPONENT
Trade mark-up	$1.00	0.499	0.501
Producer's price	1.00	0.469	0.531
Total consumer's price	2.00	0.968	1.032

Slightly less than 97 cents of every $2.00 purchase pays for either the producer's or retailer's informational requirements. The other $1.03 pays for the matter and energy component.

The output of the secondary information industries includes advertising (purchased from the advertising industry) as a current account input, and therefore as part of the output price of its services. Since advertising can be a major item in the market information system, a separate accounting of the secondary services net of advertising was developed. Table 10.5 shows the co-component of h_1 that originates with advertising, and the portion of h_1 that represents pure information service production. Before the derivation was computed, the industry's total advertising expenditures were allocated between advertising directed at households (PCE) and advertising directed at intermediate demand. This allocation is the ratio of total personal consumption expenditures to total (intermediate plus final) demand. The procedure assumes that firms direct their advertising either to other firms or to households depending on the relative shares of intermediate and consumer demand. That is, if 80% of a firm's revenues is generated by personal consumption expenditures, we assume that 80% of its advertising budget is directed at households. Hence, the total secondary output originating with household demand should be reduced by the amount of advertising, to reach the "pure secondary services" shown in Column 4.

Table 10.5 shows that around 2.5 cents of h_1 is allocated to advertising, and the rest is for other secondary services. The pharmaceutical industry, #29, shows the highest ratio--13.3% out of a total h_1 of 46.9%. Industry #19, apparel, advertises least at the producer's level. (Remember that retail stores, not necessarily the manufacturers, engage in direct advertising.) Overall, 34 cents of each consumer dollar pays for pure secondary information services, net of advertising.

Additional Results

The information requirements "forced" by noninformation purchases can be estimated in several ways. For example, one could estimate the requirements forced by other firms (intermediate demand), by governments, by personal consumption, or by exports. These data are readily available by using the primary and secondary tables in different ratios. One of the most intuitively appealing ratios is shown in Table 10.6. The output of the secondary sector net of sales to final demand (e.g., R&D and royalties) appears in the numerator. This is the pure intra-firm production of information. In the denominator, we place all demand for that industry's output. The ratio, then, shows the size of the information activity generated within firms as they meet both final and intermediate demand.

TABLE 10.5: DERIVATION OF PURE SECONDARY INFORMATION SERVICES (NET ADVERTISING)

	($ Millions, 1967)		(%)	
	TOTAL ADVERTISING EXPENDITURES	COST OF ADVERTISING DIRECTED AT HOUSEHOLDS[a]	ADVERTISING COMPONENT OF h^1	h^1 NET OF ADVERTISING (PURE INFORMATION SERVICES)
Selected industries	8,787	5,223	1.4	33.9
Total Goods	5,713	3,334	2.5	17.7
14 Food & kindred products	2,044	1,393	2.3	13.6
15 Tobacco manufacturers	327	217	4.1	7.7
18 Apparel	144	104	0.7	17.7
19 Misc textile products	16	7	0.3	19.4
22 Household furniture	57	43	1.9	28.2
29 Drug,clean,toilet preps.	1,680	974	13.3	33.6
31 Petroleum refining & rel.	322	122	1.2	18.9
34 Footwear & leather prods.	48	41	1.2	16.8
54 Household appliances	268	174	4.9	21.1
59 Motor vehicles & equip.	284	103	0.7	15.9
61 Other transport equipment	26	4	0.4	22.6
63 Optical, opthalmic equip.	69	15	4.7	28.1
64 Misc mfrg (non-durable)	219	103	2.4	30.4
Total Services	3,074	1,889	1.4	43.8
65 Transport & services	278	60	0.5	56.2
68 Electric, gas, water	56	21	0.2	18.7
69 Wholesale & retail trade	2,461	1,648	1.7	48.2
75 Automobile repair	38	21	0.3	23.6
76 Amusements (non-information)	241	139	3.6	28.8

---

[a] Prorated by the amount of personal consumption expenditures to total output

Secondary output less advertising divided by PCE for the good or service.

TABLE 10.6:

INFORMATION REQUIREMENTS GENERATED BY DEMAND FOR NON-INFORMATION GOODS & SERVICES

INDUSTRY	CENTS PER $1.00 DEMAND[a]
1. Livestock & livestock products	.03
2. Other agriculture products	.08
3. Forestry & fishery products	.05
4. Agriculture,forestry,fishery svcs	.13
5. Iron & feroalloy ores mining	.13
6. Nonferrous metal ores mining	.13
7. Coal mining	.12
8. Crude petroleum & natural gas	.14
9. Stone & clay mining & quarrying	.17
10. Chemical & fertilizer mineral mining	.12
11. New construction, net	.22
12. Maintenance & repair construction,net	.27
13. Ordnance & accessories	.35
14. Food & kindred products	.12
15. Tobacco manufacturers	.09
16. Broad & narrow fabrics,yarn&thread	.09
17. Misc textile goods & floor coverings	.11
18. Apparel	.14
19. Misc fabricated textile products	.12
20. Lumber & wood prod, exc containers,net	.11
21. Wooden containers	.14
22. Household furniture	.17
23. Other furniture & fixtures, net	.19
24. Paper & allied prods exc containers	.24
25. Paperboard containers & boxes	.20
26. Printing & publishing	.64
27. Chemicals & sel chem prod, net	.16
28. Plastics & synthetic materials:	.16
29. Drugs,cleaning&toilet preparations	.33
30. Paints & allied products	.21
31. Petroleum refining & related industries	.11
32. Rubber & miscellaneous plastics prods	.18
33. Leather tanning & ind leather prods	.10
34. Footwear & other leather products	.16
35. Glass & glass products	.21
36. Stone & clay products	.19
37. Primary iron & steel manufacturing	.14
38. Primary nonferrous metal mfg.	.10
39. Metal containers	.16
40. Heating,plumbing&structural metal prod	.18
41. Stampings, screw machine prods&bolts	.17
42. Other fabricated metal products	.17
43. Engines & turbines	.16
44. Farm machinery & equipment	.17
45. Construction,mining,&oil field equip	.20
46. Materials handling mach & equip	.21
47. Metalworking mach & equip	.22
48. Special ind mach & equip, net	.23
49. General ind mach & equip	.21
50. Machine shop products	.25
52. Service industry machines	.17
53. Elec ind equip & apparatus, net	.26
54. Household appliances	.22
55. Elec lighting & wiring equip	.22
58. Misc electrical mach, net	.23
59. Motor vehicles & equip	.11
60. Aircraft and parts	.33
61. Other transportation equipment	.16
62. Scientific & controlling instruments	.29
63. Optical, ophthalmic&photo equip,net	.27
64. Misc manufacturing, net	.23
65. Transportating & warehousing	.22
68. Elec, gas, water & sanitary svcs	.09
69. Wholesale & retail trade, net	.42
70. Finance & insurance, net	.70
71. Real estate and rental, net	.11
72. Hotels;personal&rep svcs exc auto,net	.15
73. Business services, net	.83
75. Automobile repair & services	.16
76. Amusements, net	.28
77. Medical, educ'l svcs&nonprofit orgns.	.37
78. Federal govt enterprises, net	.50
79. State & local govt enterprises	.21
80. Imports	.00
81. Business travel, entertain & gifts	.03
82. Office supplies	.00

---

[a] The requirement represents intermediate secondary information output generated by total final demand for the noninformation good or service.

FOOTNOTES

[1] W.A. Niskanen, *Bureaucracy and Representative Government* Aldine-Atherton, Chicago, 1971. See Chapter 11, "The Multi-Service Bureau."

[2] Niskanen, ibid., p. 61. A numerical example of his model yields the following results:

EQUILIBRIUM LEVELS OF OUTPUT FOR SEVERAL FORMS OF ORGANIZATIONS
FACING THE SAME DEMAND AND COST CONDITIONS

($, equilibrium values)

	MONOPOLY		COMPETITOR	BUREAU	
	Uniform	Discriminating		Uniform	Discriminating
Output[a]	50		100		200
Total revenues	$7,500	8,025	10,000	19,444	20,000
Average revenues	150	144	100	117	100
Marginal revenues	100	89	100	33	0
Total costs	4,375	4,553	10,000	19,444	20,000
Average costs	88	82	100	117	100
Marginal costs	100	89	100	158	125
Profits	3,125	3,472	0		

[a] Service units, Q.

Bureaus produced a higher output at higher marginal cost than discriminating monopolists. Both were "less efficient" than competitive firms.

CHAPTER 11

THE ELEMENTS OF INFORMATION POLICY

We have now completed a broad tour of the information economy. To some, only the rough contours have been explored. To others, the level of detail has been ponderous. We have seen that the information activity is immense, touching every aspect of economic life. One purpose of this Chapter is to reflect on the implications of our economy's voracious appetite for information goods and services.[1] In particular, I shall focus on the policy issues stemming from new applications of information technology.

The second purpose of this Chapter is to offer two recommendations: one regarding Executive reorganization in response to information policy issues; the other regarding the wisdom of institutionalizing the measurement of the information sectors.

An Information Policy Framework

By 1907, economists and social historians realized that the industrial economy was in full swing. The basic industrial technology had been invented a half century before, developed a quarter century before, and was then diffusing rapidly to all sectors of the economy. By 1907, social patterns had begun to respond. New industries, new products, new services, new occupations, new lifestyles -- all were propelled by the force of a technological revolution.

By 1977, only 70 years later, we are entering another phase in economic history. We are just on the edge of becoming an information economy. The information technologies -- computers and telecommunications -- are the main engines of this transformation. And we are now seeing the growth of new information industries, products, services and occupations which presage new workstyles and lifestyles based on intensive use of information processing and communication techniques.

The foundation of the industrial economy, the central fact at the core of that great transformation, was the ability to harness energy, exploit its power, and manipulate matter. Energy became our slave. Matter was dissolved and reshaped in any image for which we found use or pleasure. To expand our new power, we built an elaborate infrastructure that spanned the continent and connected every state and town. We built an energy grid to distribute electricity; we built a highway network to give us physical mobility; we built a railroad system to speed raw commodities and finished goods from producers to consumers. Our country became tightly integrated into a unified industrial economic system.

The foundation of the information economy, our new central fact, is the computer. Its ability to manipulate and process information represents a profound departure from our modest human abilities. The computer is one essential component of the *information infrastructure.* The other member of the infrastructure is the telecommunication network. The telephone lines, microwave stations, satellites and frequency spectrum are the analogs to the electrical and transportation grids of the industrial economy. Whereas mobility in physical space is achieved through roads and railways, mobility in information space is gained through the telecommunication network.

Our concern with information, then, is simultaneously and inextricably linked to computers and telecommunications. Today's methods may not include information technology; but tomorrow's will. Wherever information is produced, stored, manipulated or distributed, information technologies will eventually be used. The ordinary typewriter is quickly being replaced by a "smart" terminal; the U.S. Postal Service is being invaded by information machines; ordinary retail stores are being transformed by exotic looking light pens and computerized cash registers.

The rapid diffusion of computer and communication technologies carries tremendous force, as evinced by the changes following the diffusion of industrial technologies. With each new application of information technology, economic or social tensions may surface. Some might be resolved by market forces, common sense or luck. But many more, not easily soluble or analytically obvious, will rise to the level of policy issues.

"Vertical" Policy and "Horizontal" Problems

When the industrial economy came of age, the engine and the highway combined to form a powerful industrial infrastructure. Transportation policy, at that time, focused inwardly on the competing claims made by owners of alternate modes of transportation. The railroad, truck and barge industries fought with each other for market share, building cartel arrangements that were later struck down by the Department of Justice (and reestablished by the ICC under a new guise.) The internal problems of the transportation sector dominated our national transportation policy. The horizontal effects of transportation policy on other sectors of the economy -- such as agriculture, mining, manufacturing and trade -- were relegated to second place. Once the competing claims were resolved, the chips fell as they may, and the rest of the economy adjusted.

If the interindustry effects of transportation policy were treated casually, then we can safely say that the non-market effects were totally ignored. Hardly a word was breathed in the 1890's about the potentially destructive effects of transportation on the environment, on inner cities, on social adjustments. Henry Ford sold cars and trucks; the suburb, the collapse of the inner city, environmental pollution, energy shortages and a stream of property damage and broken bodies emerged much later.

After the inventors work their miracles and entrepeneurs push ideas into material realities, we are left with the untidy portion of the problem: the externalities. Enter the academic economists and sociologists, who are brought in after economic and social realities are upon us, to measure the rate at which the horse left the barn. Then, as now, few with power paused to reflect on the implications of the new technology. Our body politic did not anticipate the industrial society; it just happened.

A disturbing analog exists today. The infrastructure of the information economy is receiving some attention at a national policy level. The Communications Act of 1934 created a regulatory instrument to deal with matters internal to the telecommunications industry. Thus, the FCC, OTP, the House and Senate Subcommittees on Communications and the Office of Technology Assessment are absorbed with the fallout of the Communications Act: issues of competition vs. regulation, innovation, efficient and fair pricing, propagation of service, reliability, interconnect standards, return on investment and international tariff arrangements. These issues are indeed pressing, as the number of players and the stakes escalate yearly. To illustrate, AT&T reported (in 1976) annual profits approaching $4 billion on revenues of almost $40 billion, on investments of $123 billion, and through the toil of almost one million employees. When we add to AT&T's figures those of the other telecommunications giants (GTE, ITT, RCA, Western Union), and add to that the computer giants (IBM, Honeywell, CDC, DEC), and add to that the other "information technology" manufacturers (Xerox, AM, GE), and add to that the enormous political power of the broadcasting concerns (the television networks, radio and CATV), we begin to appreciate the stakes.

Telecommunications policy is an appropriate starting place, but it is not enough. A telecommunication policy that ignores the computer is as barren as the reverse case. Our electronic interstate highways are now increasingly digital, and the most interesting new applications are precisely at the intersection between computers and communications.[2] The offspring of that irresistible union are the policy problems of the future, and the relevant policy agencies are now beginning to broaden their sights to include the computer and telecommunications. Indeed, the FCC and the courts are now trying to establish the boundary between computers and communications, and to ask the fundamental question regarding the government's basic presumption for or against regulation. Those are welcome signs.

The inventory of important research topics regarding the "vertical" problems of the information infrastructure is lengthy indeed. And unless we have educated ourselves about the many critical technical, economic, legal and political issues, policy making will suffer.

But even that is not enough. To stop there denies a fundamental insight about the nature of new technologies. The important policy issues are not just internal to the ownership and management of the information infrastructure. (The analog to transportation policy in 1907 is clear.) The problems arise when the computer and telecommunications combine into "information technology" and invade other sectors of the economy. It is the external effects of information technology which today beg attention.

No portion of the U.S. economy is untouched by information technology. Wherever people produce knowledge, communicate ideas, make decisions, write letters and generally do what humans do best -- manipulate symbols -- information technology is lurking nearby. Some sectors of the economy have already been deeply influenced by information machines -- banking and finance for one. Others, such as the dentists' office, are less prone to drastic change.

The leading argument is that the impacts of information technology (horizontally) across all other sectors of the economy are too important to be left to technologists. Decisions that are made (vertically) within the communication policy and business worlds can affect many external constituencies, whose voices and concerns are not always heard by those making decisions about information technology. When we restrict the scope of policy attention to the pitched battles and fireworks within the telecommunications-cum-computer world, our perspective is too narrow, and society's interest is not properly served.

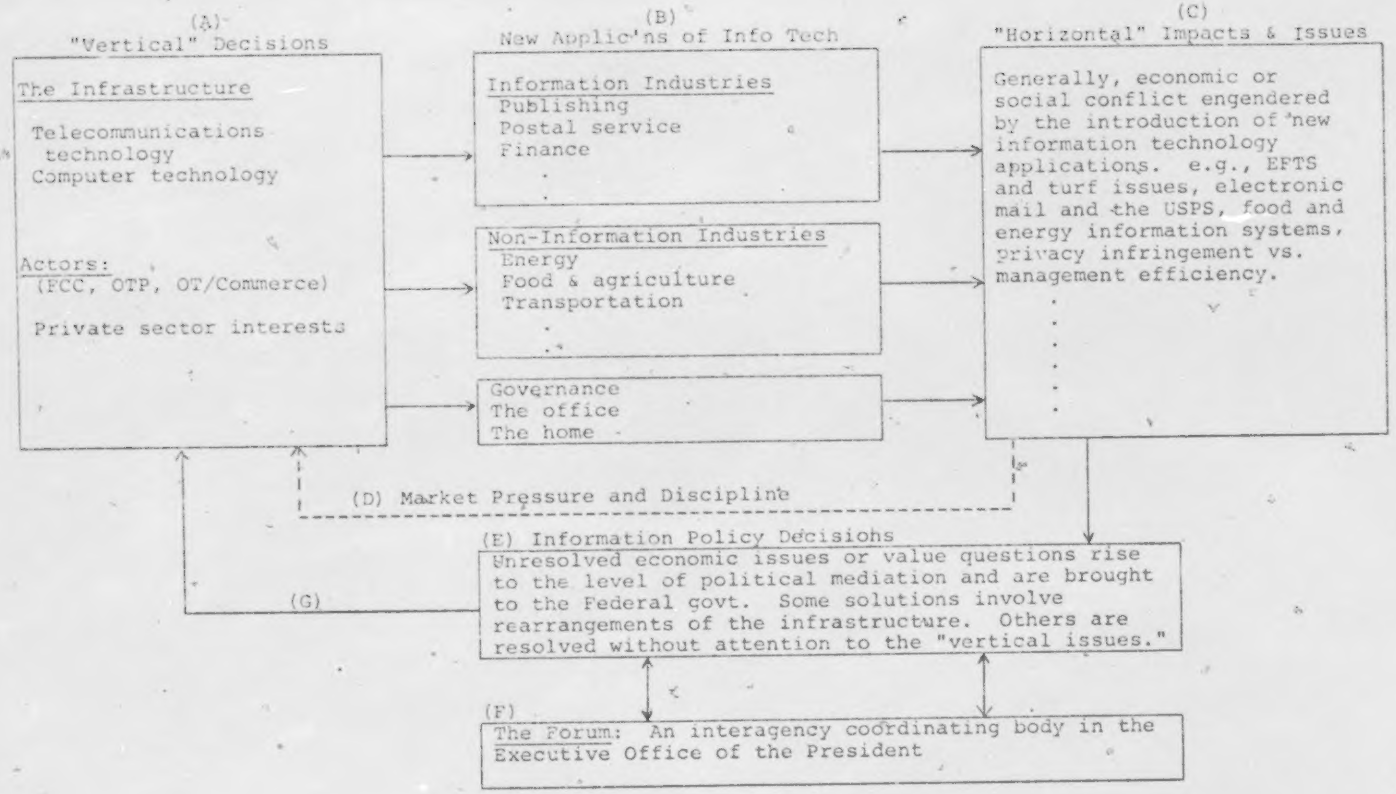
The Elements of Information Policy

First, a definition: *Information policy attends to the issues raised by the combined effects of information technologies (computers and telecommunications) on market and nonmarket events.*

A national information policy has not been devised, nor has the appropriate governmental machinery been built. In this section, we identify the elements of such a policy, and suggest a principle for its formulation.

In the introductory Chapter, we saw an abstract of the information policy framework. Here, we add detail and specifics. The framework reveals a flow of impacts, issues and decisions that revolve around information technology. (Figure 11.1 is an expansion of Figure 1.1). (A) The causal engine in this policy world is information technology, and the new capabilities that it offers.[3] (B) Private and public decisions regarding the information infrastructure, coupled

FIGURE 11.1: AN INFORMATION POLICY FRAMEWORK


(A)
"Vertical" Decisions
The Infrastructure
Telecommunications technology
Computer technology
Actors:
(FCC, OTP, OT/Commerce)
Private sector interests
(B)
New Applic'ns of Info Tech
Information Industries
Publishing
Postal service
Finance
Non-Information Industries
Energy
Food & agriculture
Transportation
Governance
The office
The home
(C)
"Horizontal" Impacts & Issues
Generally, economic or social conflict engendered by the introduction of new information technology applications. e.g., EFTS and turf issues, electronic mail and the USPS, food and energy information systems, privacy infringement vs. management efficiency.
(D) Market Pressure and Discipline
(E) Information Policy Decisions
Unresolved economic issues or value questions rise to the level of political mediation and are brought to the Federal govt. Some solutions involve rearrangements of the infrastructure. Others are resolved without attention to the "vertical issues."
(G)
(F)
The Forum: An interagency coordinating body in the Executive Office of the President

The inventory of important research topics regarding the "vertical" problems of the information infrastructure is lengthy indeed. And unless we have educated ourselves about the many critical technical, economic, legal and political issues, policy making will suffer.

But even that is not enough. To stop there denies a fundamental insight about the nature of new technologies. The important policy issues are not just internal to the ownership and management of the information infrastructure. (The analog to transportation policy in 1907 is clear.) The problems arise when the computer and telecommunications combine into "information technology" and invade other sectors of the economy. It is the external effects of information technology which today beg attention.

No portion of the U.S. economy is untouched by information technology. Wherever people produce knowledge, communicate ideas, make decisions, write letters and generally do what humans do best -- manipulate symbols -- information technology is lurking nearby. Some sectors of the economy have already been deeply influenced by information machines -- banking and finance for one. Others, such as the dentists' office, are less prone to drastic change.

The leading argument is that the impacts of information technology (horizontally) across all other sectors of the economy are too important to be left to technologists. Decisions that are made (vertically) within the communication policy and business worlds can affect many external constituencies, whose voices and concerns are not always heard by those making decisions about information technology. When we restrict the scope of policy attention to the pitched battles and fireworks within the telecommunications-cum-computer world, our perspective is too narrow, and society's interest is not properly served.

The Elements of Information Policy

First, a definition: *Information policy attends to the issues raised by the combined effects of information technologies (computers and telecommunications) on market and nonmarket events.*

A national information policy has not been devised, nor has the appropriate governmental machinery been built. In this section, we identify the elements of such a policy, and suggest a principle for its formulation.

In the introductory Chapter, we saw an abstract of the information policy framework. Here, we add detail and specifics. The framework reveals a flow of impacts, issues and decisions that revolve around information technology. (Figure 11.1 is an expansion of Figure 1.1). (A) The causal engine in this policy world is information technology, and the new capabilities that it offers.[3] (B) Private and public decisions regarding the information infrastructure, coupled with demand from the rest of the economy, result in many new applications of information goods and services. (C) Each application may give rise to a cluster of economic or social conflicts, at the level of market division, economic efficiency, social equity or ideology. (D) Some conflicts are resolved by the dynamics of market discipline, and require no government intervention. (E) But where the market cannot remedy inefficiency or inequity, the issues rise to the level of "information policy," and require political mediation. (F) Here, the general framework of information policy suggests a specific architectural component. The many issues generated horizontally by information technology necessarily implicate numerous Executive agencies. At present, no mechanism exists for coordinating the preferences and plans of the relevant actors. Hence, we may find the Federal Reserve Board and the Treasury planning EFTS networks without regard for the U.S. Postal Service initiatives in electronic mail. Or we may find both EPA and the new Department of Energy building parallel information monitoring systems without coordinating their plans. Or we may find that plans for a Federal data network carrying IRS and Social Security information are proceeding without attention to privacy statutes.

A policy coordinating mechanism is lacking, and is featured as the main recommendation of this study. In shorthand, we call it an information policy "Forum."

(G) Finally, certain information policy decisions may feed back to decision makers in the infrastructure. The horizontal (user) community may realize that it is precluded from offering certain services because of institutional rules in the vertical (supply) sector. Alternately, the horizontal community may bring prospective requirements to the attention of the vertical sector. The Forum would again play a coordinating role, by bringing such feedback to the shapers of the infrastructure.

The heart of the story centers on the new applications of information technology, the policy issues raised by these applications, and the loci of Executive responsibility for meeting those issues. We have adopted a simple form of "technology assessment" to trace the new uses of information technologies across several major sectors of the economy. The purpose of the exercise is to demonstrate that information technologies are transforming the way things get done; that some of these transformations raise thorny policy issues; and that the loci of Federal responsibility are widely scattered and disorganized.

The exercise is divided into three parts. First, we look at the impact of information technology on its close cousins -- those industries which we include in the primary information sector" (Table 11.1). Second, we look at the impact on unrelated sectors, those which we call "noninformation industries" (Table 11.2). *Third*, we look at the impact on general social processes, such as governance, the office and the home (Table 11.3).

This technology assessment is panoramic; it does not pretend to achieve depth or accuracy. Such a study could be done, but falls outside the purpose of this work.[4] Our main intent is to show the wide domain covered by information policy. (Note that some of the policy issues raised by applications of information technology are new, others are not. For example, EFTS policy did not arise before technology gave birth to a host of problems; but the issue of velocity has been with us since Irving discussed it in the 1920's. Information policy either emerges *de novo*, or casts old policy issues in a new light. It *is* often an organizing perspective, emphasizing the informational aspects of preexisting problems.)

So far, our discussion of information policy is firmly rooted in technological change. We chose to lay aside the purely ideological issues, and instead to focus on those issues which are born of deeper currents in economic life. This perspective assumes technology as the major engine of economic and social change.[5]

A completely different approach to information policy focuses primarily on the non-technological, or ideological, issues. For example, government information *distribution* policy is not necessarily influenced by information technology. Agencies such as the Census, EPA, FTC, OSHA and HEW gather volumes of potentially sensitive information. The decision over which data should be gathered is often political. So is the decision over which data should be distributed publicly. The implementation of 1st Amendment, Freedom of Information, Privacy, and "Sunshine" statutes is precisely at the center of essentially non-technological information policy. Such policy is ideological, directly addressing the tenets of republicanism and accountability. We would err grievously to suggest that all information policy has technological roots. In fact, some of the most insightful debate about the future course of our society occurs at the ideological level.

Ours is not a wholly materialistic argument, and there is ample room for political debate. A central feature of information policy is that political preferences *can* help influence the technology and cause it to *take* shape along ideational lines. In this crude model, ideas influence technology; but the technology eventually determines economic reality. For example, a high-level policy might be taken to encourage the provision of (horizontal) information services as a desirable direction for U.S. economic development. The specific technical recommendation, tied to the policy, is to ensure that data networks are "open" -- i.e., along the common carrier concept -- rather than proprietary. This point is especially salient in the case of EFTS networks. If such networks were wholly owned by private financial institutions, then competing service providers would be unable to pass the entry barrier associated with the initial high capital investment. If all EFTS networks are common carriers, then any provider of financial (and related) services could gain access to a wide national market.

Or, if a "horizontal" policy decision were taken to propagate information service delivery to rural parts of the country as quickly as possible, a "vertical" policy would emergy: that the various common carrier entities (AT&T, specialized common carriers, VAN's, satellites) are required to interconnect universally. The effect of such a policy would be to ensure that a rural town would gain access to the national data network if any of the common carrier entities entered the region.

The connection between ideology and technology is also apparent in the field of privacy protection. Invasion of privacy is not a new legal or ideological issue -- it dates back to English common law, as spelled out in an 1890 Harvard Law Review article by Louis Brandeis.[6] But the potential for mischief and damage has been immeasurably heightened by new information technologies. Seemingly innocuous systems, such as efficiency-minded computerized medical files can be sadly abused with relatively little effort. The perpetrators often act with impunity, as the act of "theft" does not physically capture the data base, but only the information.

A horizontal policy decision to safeguard personal privacy (e.g., in finance, insurance, educational, medical and general personnel files) ultimately reduces to vertical decisions regarding control of and access to the information technologies. The vertical policies focus on issues of computer and transmission security and liability. But neither perspective completely solves the problem. Institutional sensitivity must be coupled with technical design if the privacy problem is to be solved. The horizontal and the vertical (or the ideological and the technological) must work together.

The following section reveals that the opportunities for policy coordination are enormous, and ripe for harvest. To seize the opportunity *will require some reorganization of the Executive branch.* Note the many agencies that are implicated in the various aspects of information policy. In the final section, we shall introduce the concept of a "Forum" as a major recommendation flowing from this study.

Information Technology and the Primary Information Sector

The axiom is: *The more information-intensive the industry, the greater the potential impact of information technology.* It follows, therefore, that the members of the primary information sector are highly susceptible to evolutionary pressures wrought by the new information technologies. With the intermarriage of previously distant and unrelated industries, there emerges a definite "sameness," a technological kinship. For example, many have predicted that electronic mail and electronic funds transfer systems will one day lose their identity and merge into one system. The matchmaker -- information technology. Starting with totally unlike industries, we will come to find both mail and money transmitted through satellites, sped through microwave and terrestrial cable, stored-and-forwarded in computers and delivered on a high speed terminal in hard copy or as a video image. The institutions of financial intermediation and message delivery will also converge. Rather than write and mail checks, we will push buttons on EFTS terminals; rather than receive our monthly utility bill, we will receive an electronic "notice" on the home communication center.

The same technologies will also alter the shape of educational institutions, newspaper publishing and the media. It is quite unlikely that the members of the primary information sector can remain autonomous twenty years hence. And with convergence comes the inevitable friction. Who claims what turf? At what price? How is the pie to be jealously divided? (Many seem blind to the fact that the pie itself is growing by leaps and bounds.)

Table 11.1 offers a capsule summary of five primary information industries -- banking and finance, education, information utilities, postal service and publishing. A nonexhaustive list of new information technology applications is provided for each. Note that this does not constitute a carefully designed technology assessment. A complete assessment would identify the new technological applications in great detail, elaborate on the policy issues and carefully identify the loci of Federal responsibility. That task falls outside the scope of the present NSF grant. The list does, however, include applications that are generally anticipated in the literature.[7]

The Banking & Finance sector is undergoing a most remarkable change. Electronic funds transfer systems raise numerous issues, as shown in Table 11.1. Note the multiplicity of Federal agencies with authority in this area. The "information policy issues," which flow directly from the new applications, are relatives of more traditional banking or finance policy. For example, price stability is a foundation of macroeconomic policy. But the emergence of electronic commodity exchanges brings a new perspective to an old problem. It thus becomes a member of the information policy domain.

The Education sector has experimented for many years with information technology. Some spectacular failures were suffered by early attempts to use computer-assisted instruction. Recently, the notion of lifelong learning systems and individual instruction have gained greater support, especially in the area of retraining the labor force.

The Information Utility industry has sprung up around the general availability of inexpensive time-sharing computers. It is a small industry, but we include it because of its tremendous growth potential. This industry includes a new class of "information brokers," whose purpose is to package information in a form which is useful and compact.

The Postal Service is embroiled in controversy and uncertainty regarding electronic mail. The basic premise of the post -- moving pieces of paper through "hail, sleet and snow" -- is somewhat romantic and of limited use. Should the monopoly on first-class messages be broken? What are the short-term dislocations in shifting from a conventional to a digital postal system?

The Publishing sector is in a similar state, although its future is not in critical danger. Information technologies are entering the newspaper and magazine industries, changing the way things get done. In the United Kingdom, the PTT is experimenting with teletext systems, (electronic newspapers) as a major competitor to the conventional newspaper. Is this an issue for government policy, or is it better handled by market dynamics?

The primary information sector includes 21 major industries; only five are treated in Table 11.1. The whole story, as it develops in the remainder of this century, should prove to be one of major interest. It is here that information policy will receive its most urgent tests.

Information Technology and the Noninformation Sectors

Just because an industry does not primarily process or distribute information, it is not exempt from the impact of information technology.

TABLE 11.1: INFORMATION TECHNOLOGY AND THE PRIMARY INFORMATION INDUSTRIES

BANKING AND FINANCE APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
ELECTRONIC FUNDS TRANSFER SYSTEM (EFTS) Interbank FTS and check clearing Federal Reserve System FTS check clearing National credit checking Debit/credit cards Retail "branch banks" and street corner "autotellers" Retail shop automatic tellers Intrabank and "national bank" communication systems & MIS	*Generally:* Distinction between S&L's & commercial banks; Ownership and control of the EFTS network; Conflicts of interest viz. fiduciary duties; Antitrust implications of vertical integration in banking; Status of electronic branch banks, "autotellers"; Cost allocation, pricing of services; The Float: who appropriates the surplus?; Interaction between EFTS and electronic mail (see Postal Service," Table 1.2)	*Generally:* Federal Reserve Board, Treasury, FDIC, FSLIC, Comptroller of the Currency, Electronic Funds Transfer Commission, Justice (Antitrust & Economics Division), Securities & Exchange Commission, Internal Revenue Service
	Embezzlement, fraud, computer-assisted crime;	Justice (FBI), IRS
	Liability in case of theft, disruption of service;	FDIC, GAO, Comptroller, FSLIC, Fed. Res., FDIC
	Privacy: confidentiality of personal & business records	National Commission on Privacy, FTC
	Access to EFTS by small business, minority business;	SBA, Commerce (Office of Minority Business Enterprise)
	Laundering procedures using computers;	Justice (FBI), IRS
	Velocity: money supply management	Fed Res Board, Treasury
	Personal credit overextension;	
	Settling the locus of Federal vs. State regulation;	
	Security: encryption, entry identification;	Fed Res Board, Commerce (NBS)
	Security: who bears the responsibility?	
	Security: system sabotage, mass failure;	
	Resource sharing; interconnect standards	FCC, Fed Res Board, USPS
o Electronic stock exchanges and Electronic commodity exchanges	o Price stability; fiscal soundness; reliability of evidence of stock & bond transactions; o Price & supply manipulation	SEC
o Complex financial services to small depositors	o Equal access	

TABLE 11.1: INFORMATION TECHNOLOGY AND THE PRIMARY INFORMATION INDUSTRIES - (Cont'd)

EDUCATION

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
EDUCATIONAL TECHNOLOGY SYSTEMS	*Generally:* Who pays? How to measure costs & benefits?	
o Lifelong learning	o Education, literacy, job improvement;	HEW (NIE), DoL, CPB
o Labor retraining (vocational, certification)	o Labor productivity, structural unemployment: horizontal & vertical mobility; o Job matching & satisfaction; reduction in turnover;	DoL, National Commission on Manpower; National Commission on Productivity
o Teaching the chronically unemployed	o Unemployment, labor force mobilization	
o Teaching the disadvantaged, physically handicapped	o Hard-core unemployment; quality of life;	ACTION, DoL
o Open University (advanced courses, matriculation)	o Access to advanced training	HEW (NIE), NSF, CBP, FCC
o Prisoner rehabilitation	o Rehabilitation; recidivism reduction	Justice (BoP), LEAA
o College, high school and elementary schools computer time-sharing systems	o "Computer literacy"; demystifying the computer; advanced research; educational R&D	NIE, NSF
o MIS in educational institutions	o Efficient mgmt. of school systems; forecasts & requirements;	HEW (NIE), HEW (OE), BLS
o Library technology: MARC files, bibliographic search system, mass storage media (microfilm & fiche); copying media	o Library efficiency & cost effectiveness; copyright & ownership of intellectual property; resource-sharing	Library of Congress, Commission on Library and Info Science, Commerce (Patent & Copyright), the National Libraries
o Individualized computer-assisted instruction (PLATO)	o More effective instruction; impact on the educational labor force	HEW (OE, NIE)
o Interuniversity Consortia (EDUCOM, EDUNET, NEXUS, ERIC)	o Resource-sharing; equalization of opportunity to classrooms & library facilities	HEW (NIE), NASA

TABLE 11.1: INFORMATION TECHNOLOGY AND THE PRIMARY INFORMATION INDUSTRIES - (Cont'd)

INFORMATION UTILITIES		
APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
INFORMATION STORAGE AND RETRIEVAL		
General library citations	o Scholarly and general research; systematization for the publishing trade	Library of Congress
Scientific & technical information documents	o Promoting diffusion of knowledge; dissemination of public information	NSF, Commerce (NTIS), Nat'l Commission on Lib & Info Science
Medical abstracts	o Diffusion of medical research findings and practices	HEW (NIH, Nat'l Lib of Medicine)
Chemical abstracts	o Diffusion of chemical research findings	
Patent information	o Invention and R&D guidance	Patent & Trademark Ofc.
FINANCIAL SERVICES		
Accounting & balance sheet preparation	o Access of high-powered managerial techniques to small businesses	SBA
Billing, invoicing, & record keeping	o Efficiency and streamlining of record-keeping and bureaucratic burden	National Commission on Fed. Paperwork, GAO
Investment project simulation	o Rapid analysis of investment decisions *Generally:* issues of liability, theft, privacy	
MEDICAL SERVICES		
Clinic & hospital recordkeeping	o Access of costly techniques by small hospitals and clinics, Medicare reporting & actg. reqmts.	HEW
Nutritional advice: individual dietary info	o Preventative medicine *Generally:* benefit/cost questions, privacy	
ENGINEERING SERVICES		
Design analysis (cost, parts, structural test)	*Generally:* benefit/cost questions, liability in case of litigation	DoD (ARPA)
Architectural design		
EDUCATIONAL SERVICES		
Computer-assisted instruction	*Generally:* implementation of educational research & technique; individual, self-paced attention; student motivation	HEW (OE, NIE)
Remedial, vocational, special assistance	Solving unique educational problems	HEW (NIE), VA

TABLE 11.1: INFORMATION TECHNOLOGY AND THE PRIMARY INFORMATION INDUSTRIES - (Cont'd)

POSTAL SERVICE

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
ELECTRONIC MAIL Message delivery between Postal Offices Message delivery to major office buildings Message delivery to offices and small businesses Message delivery to houses *Generally:* combination of satellite, microwave, terrestrial and facsimile hardware systems Financial transactions mail/EFTS Combination EFTS and routine mail (e.g., utility bills)	*Generally:* Efficient delivery of transaction mail; Urban and rural concerns; Uses of satellites and broadband capacity; Interaction between electronic mail and EFTS systems (see "Banking & Finance," Table 11.1); Monopoly justification for 1st class carriage; Public vs. private vendors; labor dislocations Political strength of postal unions; Access to electronic mail services; Pricing, cross-subsidies; Delivery schedules	*Generally:* USPS, Postal Rate Commission, FCC, NASA, Commission on EFTS, Fed Res Board, Social Security Admin, Treasury, USDS (Rural Telephone Bank) DoL
o Rural satellite transmission of mail	o Equity with urban centers	HUD
AUTOMATED EQUIPMENT		
o Sorting, zip codes; optical code recognition	o Cost effectiveness, quality control	USPS
o Mailing list management; pre-sorting	o See "Wholesale & Retail Trade"; o Privacy & invasion (nuisance mail)	National Commission on Privacy

TABLE 11.1: INFORMATION TECHNOLOGY AND THE PRIMARY INFORMATION INDUSTRIES - (Cont'd)

PUBLISHING		LOCUS OF
APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	EXECUTIVE RESPONSIBILITY
NEWAPAPERS AND MAGAZINES	*Generally:*	*Generally:*
Remote terminal entry (reporter on location Interactive parallel editing Automatic page make-up and space allocation Photocomposition Computer-monitored printing presses	Access: small vs. large newspapers' ability to afford the technology; Localism: impact of national newspapers and centralized editorial staffs; Alteration of scope and content of news coverage; Concentration of communications ownership; Survival of dailies and multiple-paper cities	Justice (Antitrust)
Satellite transmission for parallel printing Computerized "morgue" storage & retrieval National wire-services & information brokers	Broadband & satellite capacity	FCC, NASA
o Information utilities & facsimile transmissions	o See "Postal Service," Table 11.1; copyright problems o Substitution by teletext services (e.g. Viewdata)	Commission on New Tech. Uses of Copyrighted Material
BOOKS AND REPORT PREPARATION		
o Text-editing and word processing systems	o Efficiency and cost-saving	GPO, GSA
o Photocomposition o Microfiche publishing	o Low-cost reference material; o Domestic & international technology transfer	Library of Congress, NSF, State (AID)

Communications networks encourage vertical and horizontal integration in *all* industries -- manufacturing and distributive -- leading to the emergence of regional, national and multinational firms. The far-flung Egyptian empire could not have developed had Alexandria not been graced with the "new" technologies of paper and ink, algebra and written language. On a more modest scale, if one took away Sears and Roebuck's computer network, the marketing giant would collapse into a collection of autonomous retail stores. If one stripped the Atlantic & Pacific Tea Company of its inventory control computer system, its profit margin would sink below the already razor's edge 3%. And if one denied General Motors its use of process-control automation, numerical control machines and automatic inspection sensors, the price of automobiles would skyrocket.

The computer is the mainstay of all research and development, from the useful (scientific discovery) to the trivial (product differentiation). All firms are now thoroughly habituated to computer management information systems (MIS). The uses of MIS are as varied as the imaginations of the managers and their programmers, and largess of the budget office: inventory control, production cost accounting, waste management, revenue accounts, personnel records, billing, financial simulation, P&L statements, market demand forecasts, and the omnipresent government paperwork requirements.

The computer is a central fact of the modern corporation. And if the corporation is geographically dispersed, teleprocessing is also a fact. Computers now merrily chat to each other across continents and oceans. Where satellites are the mode of transmission, the cost of communication is quite insensitive to distance. It may cost almost as much to link a New York and a Boston computer as a New York and Paris pair. The telling difference may be in the discriminatory rates imposed by national PTT's (post, telephone and telegraph administrations), whose sense of nationalism is currently lagging technology by several decades.

Table 11.2 shows some obvious applications of information technology in six illustrative sectors: construction and housing; energy; food and agriculture; health and medicine; transportation; and wholesale and retail trade. Some of the applications read like *Future Shock*, others are more familiar. Together, they weave an image of a society whose reliance on information is sharpened, and whose production motto is "work smarter."

The *Energy* sector has dramatically intensified its use of information in the last ten years. Satellites explore land and ocean masses for telling signs of hidden resources. Computers are used for massive data reduction to pinpoint drilling and mining prospects, for resource management, and for inventory of stockpiles and reserves. Corporate policy

TABLE 11.2: INFORMATION TECHNOLOGY AND THE NONINFORMATION SECTORS

ENERGY APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
o Resource exploration by satellite (geological structures of coal and oil deposits)	o Energy development o Project Independence; o Access to public data or public-subsidized data; o Frequency spectrum	FEA, ERDA, NASA, Interior, (U.S. Geological Survey) FCC
o Energy grid management by computer	o Energy distribution: efficiency and equity considerations	Interior (various Admins), USDA (Rural Electrification Admin), NRC, FPC
o Communication: remote exploration crews, offshore drilling units, tankers	o Energy development; o Safety o Spectrum	FCC
o Oil truck fleet and pipeline management systems	o Efficient use of capital;	FEA, ICC, FPC
o Remote sea state sensing	o Tanker safety; o Oil spill prevention	Commerce
o Weather forecasting service	o Basic planning of energy demand	FEA
o Building control & communication systems: heat, air-conditioning, lighting	o See "Housing & Construction", Table 1.3; o Energy conservation	EPA, FEA, Commerce (NBS)
o Data processing and reduction from exploration test sites		Interior
o Refining process control minicomputers Simulation studies	o Maximizing likelihood of a "hit"	Interior
ENERGY MIS		
o Federal inventory reporting	o Basic energy planning; o Dependencies & critical shortages	FEA, ERDA, National Comm'n on Fed Paperwork, State
o Detailed stock & price reporting (e.g., old oil, "interstate" gas)	o Regulation of prices	FEA, CWPS
o Geographical distribution and stockpiling of resources	o Emergency allocation of energy, e.g., extreme weather conditions	FEA
o Cost controls	o Inflation control	CWPS
o Tracts under development		Interior
o Royalty payment system		Interior

TABLE 11.2: INFORMATION TECHNOLOGY AND THE NONINFORMATION SECTORS - (Cont'd)

FOOD AND ARGICULTURE

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
EARTH RESOURCE (EROS, ERTS) Crop & commodity inventory, reporting, forecasting	*Generally:* Frequency spectrum; Who pays for the launch?	FCC, OTP, NASA
	Economic planning; Forecasting foreign economies' conditions, demands	USDA, FAO/U.S., Interior, Farm Credit Admin, State, CIA
o Fish & wildlife monitoring systems: stock size, movement, depletion	o Hunting and fishery policy; o Law of the Sea; o Preservation of endangered species	State, EPA, Interior (Fish & Wildlife service, Endangered Species)
o Farm and forest fire detection	o Prevention of catastrophic losses	Interior (Forest Service)
o Disease, plague, insect detection and monitoring		USDA, Interior
o Weather forecasting	o Planning: crop selection, irrigation, price movements	Interior
o Basic ground & oceanic surveys and mapping	o Resource exploitation; o Property claims	Interior (U.S. Geological Survey), Commerce (NOAA)
o Monitoring weather modification experiments	o Crop production in adverse environments	Commerce
COMMUNICATION AND DIRECT BROADCAST SATELLITES o Weather and natural disaster warning	*Generally:* o Frequency spectrum; o Who pays?	FCC, OTP, NASA
o Media for diffusion of agricultural innovation (e.g., horticulture, irrigation, husbandry, sanitation, food preservation)	o Safety of persons & property in rural areas	Weather Bureau
	o "Modernization," efficiency, equal access to agricultural technologies	USDA, State (AID)
o Coordination of airborne fire fighters	o Emergency frequencies	FAA
o Coordination of fishing fleets (MARSAT)	o Frequency	Commerce (Maritime Admin)

TABLE 11.2: INFORMATION TECHNOLOGY AND THE NONINFORMATION SECTORS - (Cont'd)

FOOD AND AGRICULTURE - (Cont'd)

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
FARM MIS		
o Crop planning systems	o Efficiency; o Use of management science techniques; o Export policy and impact on domestic markets;	USDA (Economic Research Service), State, Export-Import Bank
o Inventory maintenance: domestic & foreign destination	o Shortage & surplus detection	
o Price and quantity forecasting	o Price movement; o Inflation monitoring	Council on Wages & Prices, BLS (WPI, CPI)
o Input requirements (seed, energy, chemicals, equipment)	o Interindustry planning o Federal paperwork requirements	National Commission on Paperwork; USDA
o Diagnostic and planning information services	o Efficient production; o Public information for private use;	USDA (Economic Res Svc)
o Advanced genetic research	o Search for miracle grains, "green revolution"; inate vulnerability	USDA
o Econometric research, data gathering and reduction	o Basic economic planning	USDA
o Consumer information systems: nutrition, retail shopping	o Consumer surplus, fraud	FTC, Justice
o Computer controlled environment agriculture (e.g., hydroponics, "tents")	o Search for high-yield food production techniques	USDA, NSF, State
o Crop & commodity electronic exchanges	o Price stability, price manipulation, evidence of transaction	Commodity Futures Trading Commission, BLS (WPI, CPI)

TABLE 11.2: INFORMATION TECHNOLOGY AND THE NONINFORMATION SECTORS - (Cont'd)

HEALTH AND MEDICINE

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
HOSPITAL MIS o Clerical and billing information o Patient histories o "Flags": allergies, special conditions o Schedules: drug administration, special care o Nurse's reports to the file o Physician's instructions	*Generally:* o Health care minimization; o Efficiency of hospital operation; o Efficiency and control of health insurance claims; o Emergency and castastrophic care; o Privacy and confidentiality; o Reliability and security; o Detection of fraudulent claims; e.g., unnecessary drugs and surgery, excessive in-hospital stays; o Peer review data files; o Evidence for malpractice suits o Reduction of miscommunication with nursing staff	*Generally:* HEW (Medicare, Health Resources Admin), VA, HEW (PHS), HEW (NIH), OSHA Nat'l Commission on Privacy, Justice, HEW Justice
o Rural health care via satellite radio and television	o Health care delivery; o Social uses of satellites; o Use of paramedics	HEW (PHS), NASA, AID, FCC
o Monitoring of vital signs: in-hospital and out-patients	o Emergency response; o Out patient and visiting nurse services	HEW, VA
o Inter-clinic communication and diagnostic assistance	o Efficiency and resource-sharing;	
o Ambulance and rescue vehicle: communication, remote diagnostics, monitoring vital life signs	o Efficiency; o Emergency response; o Spectrum requirements	FCC
o Communication between hospital centers and the aged, handicapped, bed-ridden	o Quality of life; o Cost reduction	HEW (Admin. on Aging), VA
o Emergency networks: epidemic warning & control, natural disaster warning and recovery	o Emergency response o Civil disorders	HEW (Center for Disease Control), Defense Civil Preparedness Agency, FCC, OTP, GSAC (Federal Preparedness Agency)
o Poison control and suicide prevention center information	o Emergency medical and psychological care; o Liability problems	HEW (PHS)

TABLE 11.2: INFORMATION TECHNOLOGY AND THE NONINFORMATION SECTORS - (Cont'd)

HEALTH AND MEDICINE - (Cont'd)

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
o Remote medical education, preventative maintenance, self-help through TV, video, CATV, 2-way CATV	o Preventative maintenance; o Low-cost health care delivery; o Uses of CATV	
o Nutrition information and education	o Preventative maintenance	USDA (Food and Nutrition Service)
LAB TEST AND DIAGNOSTICS		
o Automated blood tests o Automated tissue and biopsy disgnosis o Viral identification	o Cost reduction; o Error reduction	HEW (NIH)
MEDICAL RESEARCH		
o Library archives: storage & retrieval	o Advancement of medical science	HEW (National Library of Medicine)
o Biometric data reduction		HEW (NIH)
o National health statistics: data gathering & reduction		HEW (NIH)
o Health insurance reporting systems: claims and settlements	o Paperwork burden; o Fraud reduction; o Cost control	HEW (Medicare), OSHA, SSA
o Welfare reporting systems: claims and settlements		HEW

TABLE 11.2: INFORMATION TECHNOLOGY AND THE NONINFORMATION SECTORS - (Cont'd)

HOUSING & CONSTRUCTION

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
BUILDING CONTROL SYSTEMS	*Generally:*	
o Fire and burglar alarms	o Building design standards and codes;	HUD, Commerce (NBS), GSA
	o Federal assistance criteria;	
	o Home safety and security	LEAA, Commerce (Nat'l Fire Prevention & Control Admin)
o Heating and cooling control	o Energy conservation	FEA
o Lights and sprinkler control	o Energy and water conservation	FEA, Interior
o Utility meter reading by computer	o Reducing labor costs for utilities;	FPC
o Environmental monitoring	o Health maintenance	NIH
o Security systems (e.g., entry I.D., personal movement monitoring)	o Security;	
	o Invasion of privacy	Nat'l Comm'n on Privacy
o "Wired home" design standards (e.g., fibreoptics, direct broadcast satellite dishes)	o See "The Home," Table 11.3	
	o Design standards	Commerce (NBS)
o Architectural design using computer graphics: 3-D simulations, specialized design software	o Aesthetics;	GSA
	o Efficient building design	
PLANNING AND SIMULATION SYSTEMS		
o Urban renewal and redevelopment	o Urban policy	HUD, FSLIC, USDA (Farmer's Home Admin, REA), Interior
o Zoning and land use	o Land use policy	Interior
o Regional and local growth	o Growth policy	Interior, Commerce (Econ. Dev. Admin), SBA
o Real estate MIS	o Federal paperwork reporting	Nat'l Comm'n on Federal Paperwork
	o Tax reporting	IRS
	o Tenant/landlord dispute information;	
	o Access and ownership questions	Justice
	o Discrimination claims	Justice, HUD, FSLIC
	o Regulation of mortgage brokers	Justice
	o Public housing management	HUD, GSA (Public Building Service)

TABLE 11.2: INFORMATION TECHNOLOGY AND THE NONINFORMATION SECTORS - (Cont'd)

TRANSPORTATION APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
Generally: Optimization techniques for route, load pickup/delivery, tariffs for truck, air, rail and water transportation systems	*Generally:* Efficient use of capital and energy resources; Market partition and intermodal competition; Extent and effects of price & service regulation; Energy conservation; Increased vehicle life expectancy	*Generally:* DoT, ICC, CAB, FAA, EPA Federal Maritime Comm'n, MARAD, DoT (FHSTA), ICAO
o Truck, taxi and emergency vehicle (land-mobile) communications and control systems	Efficiency; Spectrum requirements	DoT, FCC
o Railroads: rolling stock mgmt, computerized bills of lading, optical code inventory mgmt systems	Efficiency; Loss, theft, and damage control; Paperwork reductions; Settling insurance claims; Externality to industry	DoT (Fed. Railroad Admin), ICC, NTSB
o Rapid transit: automation, dial-a-bus	o Rapid transit development; o Impact on highway trust: o Land use planning	DoT (Urban Mass Transit Admin)
o Airline and train reservation systems	o Customer service	CAB, NRPC (Amtrak)
o Highway monitoring: speed, congestion, alternate routing, lane allocation, accident warning	o Highway patrol; o Public safety; o Reduction in pollution, accidents, delay, commuting time, fuel consumption	DoT, LEAA, EPA
o Airline: air safety, ground control, autopilots	o Safety	FAA
o Facsimile & teleconferencing	o Information/transportation substitutes	
o CB Radio	o Spectrum requirement; o Emergency uses (e.g., accident, disaster)	FCC, LEAA, GSA, (Federal Preparedness Agency)
o Environmental pollution monitoring system	o Environmental protection o Public health	EPA, HEW (NIH)
TRANSPORTATION MIS		
o Tariff information	o Regulatory burden	ICC
o Route information		
o Cost controls		
o Airlines: payments clearinghouse system	o Smooth operation of domestic airline industry	CAB

TABLE 11.2: INFORMATION TECHNOLOGY AND THE NONINFORMATION SECTORS - (Cont'd)

WHOLESALE AND RETAIL TRADE

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
CATV		
o Targeted advertising o Split-cable experiments o Consumer information systems o Home retail shoping	o Consumer protection; o Invasion of privacy; o Susceptibility by children or "passive consumers"	FTC, FCC, National Commission on Privacy
	o Uses of CATV	FCC, NSF
	o Consumer surplus o Fraud prevention o Trade defamation	FTC, Justice
RETAIL STORE MIS		
o Point-of-sale terminals Optical code labels & light pen readers Automatic inventory deduction and ordering Automatic billing Applications of EFTS: debit/credit cards, the store as a "branch bank"	*Generally:* Efficiency, reduction in the paperwork burden; Cost-reduction: who appropriates the savings?;	SBA, National Comm'n on Paperwork, FTC
	Smoother operation of national exchange markets; Better inventory accumulation and decumulation control; Demand and production forecasting; Business cycle forecasting; See "Banking and Finance," Table 11.1; Legal jurisdiction issues	Commerce (BEA)
o Mailing list management, exchange brokerage	o Privacy; o Postal logjam	National Commission on Privacy; Justice; USPS, Postal Rate Commission
o Consumer Information Systems (utilities)	o Consumer surplus, o Fraud protection; o Trade defamation	FTC, Justice
WHOLESALE TRADE		
o Search services & brokerage o "Computerized auctioneer", commodity brokerage	o Promoting competitive markets; o Potential for cartel management;	Justice, FTC,
o Goods exchange and barter systems	o Reliability of evidence of transaction o Fraud	SEC, Justice, FTC
	o "Cashless"transactions: impact on tax liability	IRS

notwithstanding, the nation's energy system could be monitored with precision. Geographical resource distribution during periods of shortage, energy conservation programs and price monitoring can only be implemented if the basic data are available. The solution involves computers and telecommunications.

Similar issues are soluble in the Food and Agriculture sector. Satellites monitor global weather and crop conditions. Commodity stockpiles and movements can be tracked with accuracy . Coordinating the "food system" should become, as former Secretary Kissinger has urged, a major international concern. Again, computers and teleprocessing are a key part of the solution.

The Health and Medicine sector has already adopted information technology as a central feature. It could not afford to do otherwise. From research on cancer and heart disease to routine administration of hospital centers, the computer is a basic instrument in the physician's black bag. As Table 11.2 shows, many new applications are now being developed and implemented in this sector.

The Housing and Construction sector is affected in two ways: (i) computers are now designing office buildings, using advanced simulation and visual graphic techniques; and (ii) the office buildings and homes of the future will be environmentally controlled by a complicated communication network of sensors, microprocessors and minicomputers.

The Transportation sector would literally halt without a first-rate teleprocessing network. Airline and train reservations, freight movement, emergency vehicle control -- these are essential ingredients of a modern transportation system. The ramifications for efficiency and energy-saving take on added significance in this era of resource shortages.

The Wholesale and Retail Trade sector is now in the midst of an information technology binge. Product codes, light pens, and point-of-sale computer terminals are sweeping the sector, raising some tricky policy questions. In time, the retail store may be an integral part of the banking system, with customers making deposits and withdrawls on a routine basis.

These six selections illustrate the impact of information technology on the noninformation sectors of the economy. The point of the exercise is to counsel policy makers in the fields of telecommunication and computers to pay attention to the effect of their decisions horizontally -- on the overall economy. And conversely, to alert industry leaders that policy decisions made in the telecommunications and computer arena can promote or hinder their future plans.

Information Technology in Governance, the Office & the Home

The next table illustrates more general social and economic impacts devolving from information technology. This section looks at governance, the office and the home.

Governance is almost a pure informational activity, and we have selected three major functions for a detailed look: (i) economic planning and regulation of industry; (ii) defense and intelligence; and (iii) law enforcement and the Judicial system. In all three cases, information technologies change the *nature* of the activity itself by supplying governors with unprecedented capabilities to manipulate information. It is not surprising that some very difficult policy issues arise when these powerful new technologies are harnessed. As a people, we have usually suspected and limited our governments; omniscient governments are that much more powerful, hence suspect. But on the other hand, as a people we have come to relish and enjoy complexity. In some undefined way, complexity implies choice, and choice implies freedom. Few would turn back the riches of a complex society in return for the simplicity of a poor society. But complexity introduces a staggering information requirement on those who pretend to manage and set policy. To know completely is infinitely expensive, and so we must settle for a satisfactory level of ignorance. It is the manager's lot to make perfect decisions with imperfect information. And in the attempt to meet this impossibility, managers and their information bureaucracies try to reduce a world of complexity into something simple and understandable. The same bureaucracies, however, *add* a level of complexity to an already confused situation. And the syndrome of information overload continues.

Information systems of many types are used in *economic planning* and in *social control of industry*. As we shall stress throughout the next nine chapters, an information society is one in which planning and bureaucracy have become widespread. It matters little whether government or firms do the planning except in the distribution of welfare and income. Presumably, governments plan to maximize social welfare while firms plan to maximize profits. In either case, planning requires information.

Table 11.3 shows a number of information systems that have been developed (or are being developed) in support of economic planning. Most are already implemented in an early (noncomputerized) incarnation. I cannot at this point enter the debate on planning.[8] But whoever plans requires economic information. The better and more timely the information, the lesser the chance of egregious error.

TABLE 11.3: INFORMATION TECHNOLOGY IN THE GOVERNMENT, HOME AND OFFICE

GOVERNANCE: ECONOMIC PLANNING AND REGULATION OF INDUSTRY

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
o Automated production reporting (e.g., Census of Mfrg., Business Construction) from corporate MIS to government computers: output (by lines of business or product), prices, capacity, utilization, profits, rents, depreciation	o Basic economic intelligence; o Uniform system of accounts	CEA, Commerce (Census, BEA), Labor (BCS), Treasury (IRS)
o Automated employment reporting from corporate MIS to government computers: wage, OSHA, layoffs	o Employment and unemployment monitoring	
o Automated financial reporting: tax data, securities, overseas transactions	o Federal revenue planning: fiscal policy; o Size of the deficit; o Trade policy oversight; o Balance of payments and exchange rate forecasts	Treasury, White House, State, Fed. Res. Board, Commerce (DIBA), Tariff Commission
o Automated commodity and inventory reporting: natural resource inventory, perishables, physical location of goods	o Strategic policy monitoring	NSC
o Job bank information: national job search info system; public jobs planning system	o Reducing frictional unemployment o Managing & implementing public job programs	DoL DoL, Interior
o Consumer information system: price, quality, location, performance record	o Consumer surplus, fraud, trade defamation	FTC
o Prices and incomes monitoring system	o Price & incomes policy; o Inflation early warning & control mechanism	CEA, CWPS
o Credit and money monitoring system	o Money supply management	Fed Res, Treasury
o Capital, natural resource and labor requirements planning system	o Basic long-range planning	OMB, Commerce, DoL
o Congressional and Presidential "teleconferencing" systems (including State & local government grants and revenue sharing applications)	o Yearly program formulation and negotiation; o Flexibility; o Multi-year budgeting	White House, all Departments, OMB
o On-line access to economic planning models (e.g., Fed. Res., DRI, Chase Econometric)	o Basic economic planning tools (availability and access)	All Departments
o Automated data submission by regulated firms and industries	Conduct and performance of regulatory agencies, e.g., o FCC: monitoring cost allocation & internal subsidies; o FCC: monitoring profits and prices; o FTC: monitoring line of business data o ICC: monitoring tariff compliance o SEC: control, fiscal soundness, prevention of fraud	All regulatory agencies

As teleprocessing is introduced, a wide range of interesting capabilities could be exploited. For example, it is quite possible to capture almost daily information about the state of the economy by a conceptually simple technique. The larger U.S. corporations are addicted to management information systems. Much of the information sought by the Federal government is collected routinely on private computers. Those data selected for planning purposes (e.g., leading indicators, WPI and CPI elements, capacity utilization, labor demand, calendar of wage negotiations) can be extracted from corporate MIS at a very low marginal cost. In principle, the Federal government already extracts these data under compulsion, imposing a paperwork burden on the private sector well in excess of $40 billion per year.[9] The irony is that the government reporting system is so awkward and technologically retarded that the data are obsolete almost before they are used.[10] Instead the government could develop (at NBS) a unified, computerized reporting procedure. Corporate MIS and government MIS could then communicate via teleprocessing on a routine basis.

There are many other ways that the government can tidy its own house. The common denominator: information technology. But as any political scientist would readily confess, the technology is but a mirror of the institution. If we institutionally refuse to cooperate, then no technology will solve our fouled communications. They are, after all, fouled on purpose.

One arena where poor communications are intolerable, if not fatal, is in *defense and intelligence*. After the ICBM's are launched, one can't say, "I did not mean it." The President's hot line must always work; the President's daily national security briefings must always be accurate. In this spirit, the defense and intelligence communities have developed an extraordinary reliance on information technology. From communication satellites to artificial intelligence, DoD has lavished itself with the best that money can buy. In fact, it was DoD research that was largely responsible for many of the basic inventions in advanced information technology (e.g., the computer communication network).

Table 11.3 lists just a few applications of information technology. The largest single item is avionics, "smart weapons" and automated battlefields. National security in the 21st Century will be capital-intensive and information-intensive, as it is an imperative of declining (real) defense budgets that cheaper ways of providing national security must be found. The solution -- information technology.

A close cousin to defense is the *law enforcement* establishment. Of late, it too has adopted the trappings and artifacts of a thoroughly information-intensive

TABLE 11.3: INFORMATION TECHNOLOGY IN THE GOVERNMENT, HOME AND OFFICE

GOVERNANCE: DEFENSE & INTELLIGENCE

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
COMMUNICATION SYSTEMS: *Generally:* Defense communications Strategic Air Command Early warning defense lines Tactical communication systems Communication satellites (and hunter satellite)	*Generally:* National security Reliability & redundancy Surveillance as a deterrent Coordination, communication, command, and control Negotiating, implementing and monitoring SALT Agreement Costs and benefits of security systems Basic intelligence for policy formulation Limited response -- preserving political and military flexibility	*Generally:* DoD, DIA, NSC, FCC, NASA, NSA, JCS, SAC, DCA, FCC, OTP
		DoD (Air Force), JCS TAC DoD, State (see Convention on Peaceful Uses of Outer Space)
o Diplomatic communication network (including Presidential "hot-line," Air Force Four)	o Reliability: immediate communication with potential adversary; security of private comm'n; o Reliability: complete absence of false alarms	State, White House, NSC, DCA
o Covert communication networks	o Undetectability	NSA, CIA, DIA, FBI
o Propaganda systems o Direct broadcast satellite o Radio and television broadcast	o Claims of "cultural imperialism";	State, USIA
o Jamming, scrambling and encryption systems	o Security, encryption technology	DoD, Commerce (NBS), JCS
o Air, water and space reconnaissance systems	o Basic intelligence	DoD, NASA
o Remote sensing and interception systems (ground)		DoD
o Data consolidation and reduction systems	o Coping with the volume of military and political information	DoD, CIA, NSA, State
o Artificial intelligence systems (e.g., language translation)		DoD (ARPA)
o Dossier and personal records systems	o Privacy vs. efficiency	DoD (CIC)

TABLE 11.3: INFORMATION TECHNOLOGY IN THE GOVERNMENT, HOME AND OFFICE - (Cont'd)

GOVERNANCE: DEFENSE & INTELLIGENCE - (Cont'd)

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
SMART WEAPONS	*Generally:*	
Avionics generally	Need for skilled manpower, professional soldiers	DoD, generally
Automated battlefield	Reduction in labor-intensive police actions	
TV, radio and satellite controlled missiles	Shift from bombers to automatic weaponry Large spectrum requirements	
Laser guided missiles	Technology transfer to civilian sector	
o Simulation, war-gaming on computers	o Preparing policy options	
DEFENSE MIS		
o Procurement: RFP, negotiations, contracting, monitoring, evaluation, cost control, dispute and reconciliation data	o Cost over-runs; o Budget programming and planning; o Fraud and nonperformance litigation; o Illegal payments control; o Basic management	DoD, JCS, White House Justice Commerce
o Personnel records and files	o Privacy	National Commission on Privacy
o Logistic records and files	o Efficiency o Cost reductions through rational management	
o Congressional oversight documentation	o Accountability	

TABLE 11.3: INFORMATION TECHNOLOGY IN THE GOVERNMENT, HOME AND OFFICE - (Cont'd)

GOVERNANCE: LAW ENFORCEMENT AND THE JUDICIAL SYSTEM

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
NATIONAL CRIME INFORMATION NETWORK (and related systems)	*Generally:* Efficiency vs. privacy protection, viz:	*Generally:* Justice (NCIC, FBI), LEAA, Treasury (IRS, INTERPOL), National Commission on Privacy
o Case histories and dossiers	o 1st and 4th Amendment rights; o Compliance with Privacy Act	
o Outstanding warrants	o "Permanent memory" -- prejudice against personal change	
o Interstate flight information	o Changing or deleting inaccurate information	
o Vehicles, gun registration	o Unauthorized access to personal information (e.g., employers, insurance companies) and resulting damage)	
LOCAL POLICE COMMUNICATION SYSTEMS		
o Radio patch into NCIC computer	o Public safety -- quick apprehension of fugitives or criminals o Police safety -- immediate warning about suspects	LEAA, FBI, FCC
o Portable radios and terminals (hand carried)	o Emergency response: communication, command & control	
o Police vehicle communication and identification	o Coordination between institutions (e.g., police and fire) and jurisdictions (e.g., city, state, Fed'l)	
o Police MIS: booking, evidence files, summary statistics	o Minimizing risk of bad evidence, illegal police behavior	
o 911 Emergency telephone number	o Emergency response	FCC
COURT INFORMATION SYSTEMS		
o Closed-circuit and broadcast TV	o Prejudicial or tortious publicity; o The public's right to know; o Quality of the judicial process; o Intimidation;	Justice, NSF
o Remote testimony & arraignments (video)	o Cost, time, and travel savings; o Efficiency in the courtroom; o Automating the court stenographer	
o Court MIS: scheduling, disposition, follow-up, appeals, summary statistics, case file management	o Controlling due process and equal protection; o Reducing court delays	

TABLE 11.3: INFORMATION TECHNOLOGY IN THE GOVERNMENT, HOME AND OFFICE - (Cont'd)

GOVERNANCE: LAW ENFORCEMENT AND THE JUDICIAL SYSTEM - (Cont'd)

APPLICATION OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
o Statistical monitoring of the Judicial System: data base management	o Policy formulation and evaluation;	Justice
o Computerized legal research (JURIS, LEXIS, FLITE)	o Reducing the cost of legal research; o Questions of access and egalitarianism; o Change in use of precedents; o Low-cost legal aid;	Justice (JURIS), Air Force (FLITE), NSF
FEDERAL COMPUTERIZED PERSONAL FILES	*Generally:*	
o "Personal Identification Number; and the ability to cross-reference all Federal files	o Efficiency vs. protection of personal rights; Potential for abuse; Cascading effects of "bad memory" or misinformation;	GSA (FEDNET), OMB, National Commission on Privacy, SSA
o Ability to detect white collar (financial) crimes	o Change in perception regarding crime and criminals; o Attention shifts away from street crimes	Justice (FBI, IRS)
o Ability to detect tax evasion	o Tax revenue; o Organized crime task force	Justice (FBI, IRS)

activity. The patrolman is now armed with a portable hand-held terminal for instant "makes" on suspects. The police blotter is now a bank of CRT's which keep track of every police vehicle, "talk" to the National Crime Information Center and retrieve dossiers at a moment's notice.

The judicial system is now bending seriously under the weight of its informational load. Scheduling and tracking cases through the maze of arraignment, pre-trial hearing, trial, appeal and case disposition impose a major clerical burden on the courts. The miscarriage of justice need not always come from rigged juries, drunk judges or economic disparity. Often the injustice is the inordinate judicial delay, the frustration, and the high cost of entering the judicial maze. Some solutions are now being developed, such as court MIS, computerized legal research, remote testimony, and streamlined file management. The solution -- information technology. But again, if the institutional will is recalcitrant, no amount of fancy machines will solve the problem.

The government has much to gain from coming to grips with the informational aspects of its responsibilities. Governance is an informational activity, and the uses of information technology will increasingly become part of the solution and a feature of "information policy."

The Office and the Home

Many people spend almost all their lives either at home or in the office. These two arenas of leisure and work are about to undergo a profound change resulting from new uses of information technology.

The office has already been invaded. Typewriters are yielding to computer terminals; the letter is mutating into a facsimile or a computer-generated printout; the office information machine is a fact of life. As private bureaucracies grow, so also will the appetite for information technology.

The next frontier in this irresistible transformation will be the home. Dreamers and futurists have done us the service of being wrong. For the first time in history, we have overestimated the pace of technology The wired city was supposed to happen by 1980; the home information utility by 1985. Home communication centers, complete with two-way CATV, plasma screens, light pens, minicomputers and facsimile were to be as commonplace as toasters by 1990.

It won't happen on schedule, and there is the blessing of a bad forecast. Our society has been given a reprieve to reflect on the coming of a revolutionary new technology. We are now at the edge of an information economy, as argued

TABLE 11.3: INFORMATION TECHNOLOGY IN THE GOVERNMENT, HOME AND OFFICE - (Cont'd)

THE OFFICE

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
OFFICE AUTOMATION	*Generally:*	
Word processing and text-editing systems	Retraining clerical and professional staffs	DoL
Computerized filing, storage and retrieval systems	Reducing the cost of bureaucracy	National Commission on Paperwork, DoD procurement
	Office productivity	See Table 11.2
"Broadside" transmission of letters, memos, directives	Impact on EFTS, Postal Service industries (Table 11.1)	
Electronic mailboxes	Location and land-use policy	HUD, Interior
	Channel capacity	FCC
	Opening the market for home communication systems	
MANAGEMENT INFORMATION SYSTEMS		
o Financial control	o Corporate strategy, planning & evaluation	
	Federal paperwork burden and government monitoring of business activity;	Justice, FTC
o Accounting, billing, record keeping	Subpoena by Federal Government or private discovery actions;	
o Process Control Information	Public's right to corporate data	
o Scientific and financial computer simulation	o Innovation, R&D	
o Scientific and technical information systems	o Diffusion of innovation;	
	o Amortizing public R&D expenditures	NSF, DoD (ARPA)
o Mass storage record-keeping systems	o Disaster or holocaust recovery	GSA (Fed'l Preparedness Agency
o Remote offices (home, on travel)	o Flexibility in work locations and time (see "The Home" Table 11.3)	DoL, DoT
o Information utility and brokerage services	o Liability;	
	o Access by small firms	Justice, NSF, FTC

TABLE 11.3: INFORMATION TECHNOLOGY IN THE GOVERNMENT, HOME AND OFFICE - (Cont'd)

THE HOME APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
HOME COMMUNICATION CENTER o Pay-TV (and on demand CTAV libraries) o Video cassettes	o Impact on the broadcast industry; o Consumer sovereignity; o Diversity o Access and nonprice discrimination; o Channel capacity	FCC, FTC
o Educational programs, home university, technical school, basic skills (reading, writing, arithmetic)	o Lifelong education; o Continuing professional education; o Labor training and productivity; o Functional literacy	HEW (NIE), DoL
o Electronic mailboxes o EFTS Applications: paying bills, retail browsing and shopping	o Impact on the Postal Service (see Table 11.1) o Impact on the banking industry (see Table 11.1); o More competitive retail markets; o Privacy (e.g., consumer profiles); o Fraud	USPS, Postal Rate Comm'n Fed. Res. EFTS, FDIC, Comptroller, FSLIC, FTC, USPS, CPSC, FDA
o Reservation system: transportation, sports, entertainment o Facsimile application: "newspaper" delivery, information utilities	o Auction of unused seats: average cost pricing o Impact on the publishing industry (see Table 11.1); o "Privatization"; o Access and equity issues; o Information gaps	
o Automatic telephone call in/out and directory; message stacking	o Interconnect standards	FCC
o Home office & terminal communication system; Teleconferencing: two-way voice, data and video	o Work and lifestyle changes; o Reduction in community land-use patterns; o Location of offices; o Multiple employment (freelance)	
o Home public opinion polling; National referenda, direct election, "absentee" balloting	o Biased sample; o Universal suffrage; o Manipulation by control of wording and question strategy; o Overreaction; o Promoting liaison between government and the people	Federal Election Comm'n

TABLE 11.3: INFORMATION TECHNOLOGY IN THE GOVERNMENT, HOME AND OFFICE - (Cont'd)

THE HOME - (Cont'd)

APPLICATIONS OF INFORMATION TECHNOLOGY	INFORMATION POLICY ISSUES	LOCUS OF EXECUTIVE RESPONSIBILITY
HOME CONTROL CENTER		
o See generally, "Housing and Construction" (Table 11.2)	See "Housing and Contruction" (Table 11.2)	
o Heat, temperature, lighting, sprinkler control		
o Burglary and fire alarm and control		
o Environmental monitoring and control		
o Automatic utility meter reading		
o Remote appliance control (e.g., oven) and diagnostics (e.g., water or gas leaks)	o Energy conservation; o Design standards	FEA, ERDA, HUD, NBS
o Energy consumption reports and diagnostics	o Energy conservation	FEA, ERDA

in the preceding chapters. But when the home is transformed by the communication center and the information utility, the information society will have arrived.

The schedule has been postponed. We have one generation to attack the literacy problem, the information gap problem, the privacy problem, the lifelong learning problem. We have one generation to plan for new lifestyles, new settlement patterns, new ways of working. These issues go far beyond the scope of this study. They are, however, a hint of what the future holds. The purveyor -- information technology. The solution -- a coherent national information policy, and the legislative and executive will to confront the issues in a sensible manner.

Recommendations

The Office of Telecommunications (OT), in its policy support role to the White House Office of Telecommunications Policy, has the responsibility to assist in formulating a policy "framework" that is cognizant of the major telecommunication issues. As a sister agency to the Bureau of Economic Analysis (Commerce), OT has a nominal responsibility to forward suggestions regarding the uses of the national accounts.

In this vein, we close the study with two recommendations: (i) that an appropriate Executive organization be developed in response to the horizontal information policy issues; and (ii) that the "activity" method of national accounting should be reviewed by the Bureau of Economic Analysis.

1. Federal Reorganization and Information Policy

Recommendation 1:

> *In response to emerging horizontal information policy issues, the Executive Branch should establish an appropriate organization to coordinate interdepartmental policy formulation.*

There have been at least three major efforts to suggest an appropriate Federal government response to the issues raised by information technologies.[11] Each has spelled out a number of organizational alternatives, ranging from the creation of a Department of Communications, to a redefined role for OTP, to an Assistant Secretary for Telecommunications at Commerce.

The purpose of this section is not to offer specific remedies. Rather, we shall argue that a policy mechanism for tracking the "horizontal" impact of information technologies is missing, and that such a capability can and should be developed.

The informal technology assessment exercise in the preceding section identified the loci of Federal responsibility across a wide range of policy issues. In some cases, such as EFTS, the responsibility is distributed across several agencies, and regulatory commissions. In other cases, such as monitoring the impact of home communication terminals, no one has the authority to set policy.

A review of Tables 11.1, 11.2, and 11.3 shows that no single agency can possibly accommodate the many diverse issues. This is hardly surprising. Information technologies enter so many sectors, that any "vertically" oriented agency cannot (and should not) develop the necessary expertise to plan, monitor, implement and evaluate information policy.[12] To create a Department of Communication at this point would be impolitic. Such an umbrella agency would invade too many claimed domains and irritate too many fixed interests. It might be desirable to develop the depth to design and execute policies in all the fields mentioned in the Tables, but it would be folly to centralize the operational or mission responsibilities.

Instead, the essence of our recommendation is to develop an analytical capability (somewhere in the Executive Branch) whose charge is to establish a horizontal perspective. This compact group should serve as policy coordinators rather than policy formulators, policy monitors rather than policy implementers. The group should assume a policy oversight role rather than a mission-oriented role. Its job is to encourage communication between the mission agencies, to alert those that are on a collision course, to facilitate interdepartmental planning and cooperation.

One might require a staff of 500 to analyze spectrum requirements; but it takes just a handful to monitor the present and future spectrum requirements suggested by the many pending applications of information technology. One might require a staff of 500 to implement and manage an electronic mail network or a Federal Reserve EFTS network, but it takes just a handful to coordinate the plans and ideas shared by the U.S. Postal Service and the Federal Reserve Board. A small group might see that an agricultural commodity inventory system can unlock the technology for an energy resources inventory system. Or that extensive use of corporate communications networks can influence land-use patterns as firms shift to rural locations.

A tautology worth repeating is this: vertically oriented agencies by definition cannot take broad horizontal views. But as decisions made in one sphere are likely to impact on the state of the world in a remote sphere, someone should be charged with looking at horizontal impacts.

Some might argue that the democratic process itself will accommodate our problem. When A makes a decision that impacts adversely on B, then B appeals for judicial or legislative relief. This is the current adversary model of confrontation, advocacy, arbitration and resolution. It works with reasonable success, if one is willing to tolerate lengthy regulatory and court proceedings and a slow-burning trial by fire in Congress. Where it works well, then fair solutions settle competing claims. But these settlements are reactive and retrospective. The adversary process does not even begin until a victim and victimizer have squared off. Only by serendipity does the adversary process accommodate prospective conflict resolution. That takes cooperation and coordination.

Others might argue that the competitive marketplace will, if left to its own devices, discipline the errant entrepeneur and induce maximum efficiency, innovativeness and equity. In many cases, the presumption for competition is sound, and market solutions prove highly preferable to political solutions. But we should not forget that the industries that form the infrastructure operate under a mixed regime of protective monopoly (telephone), regulated competition (the specialized common carriers) and unregulated competition (computer and other equipment manufacturers.) And that the major users of information technology are also subject to a multitude of Federal and State regulations (e.g., finance, USPS). And that even the "competitive" sectors (e.g., computers) are characterized by allegations of oligopolistic leadership. Even if our best sentiments are in favor of market solutions, the stark realities of existing market structure defy a laissez-faire approach.

We are thus left with the assertion that not all social and economic conflicts will find their resolution through normal market or adversary processes. But deep philosophical principles need not be invoked in support of the recommendation. A simpler approach will do. The many Executive agencies catalogued in the preceding section are today taking positions on information policy. Any contradictions, gaps and overlaps are monitored by no one. No single group anywhere in the Executive has the job. Thus, the major element of our recommendation is this: *Entrust a small group in the Executive with the responsibility to promote interagency coordination and planning in the field of "information policy."* The duties of this group are quite precise: (i) to identify those issues which naturally implicate a number of agencies; (ii) to select from that group of issues those which are appropriate for interagency consultation; (iii) to provide a "Forum" where deliberation and coordination can take place; (iv) to serve as a coordinator, when asked to do so, during the period of interagency collaboration; (v) to lend limited analytic support in the fields of technology, law, economics, and other relevant social sciences; and (vi) to close the feedback loop from horizontal impacts of information technology back to the vertical decisions in the telecommunications policy community.

This Forum does not take positions, make decisions, or organize missions. It does not have an operational role *per se*. Instead, its entire function is to promote horizontal coordination. The operational credits and liabilities reside with the traditional agencies, including the prerogatives that come with responsibility. The only new feature is that where multiagency collaboration is required, there will be a place and professional support to do so.

Although the Forum does not take positions or implement programs, it nonetheless plays an active role in the decision-making process. The key is money. We propose to locate the Forum within the Executive Office of the President. It could become an "Office of Information Policy" in OTP, a group in OMB, or in the Domestic Council. The Director of this office, who has occasional access to the President, is the logical conduit between the relevant Executive agencies and OMB. When the President, through OMB, inquires whether an issue within the information policy domain has been properly considered and "staffed out," the Director of the Office of Information Policy can speak with authority on behalf of the agencies. The Director, as coordinator, serves as the agencies' voice inside the White House. Where questions of clarification or dispute arise, the Director serves as the "point man" on behalf of the mission agencies. And, when the mission agencies have devised a common policy or a coordinated set of policies, the Director can speak in their cause about Congressional appropriations and White House support. Programmatic questions from OMB can be authoritatively answered, as interdepartmental disputes are settled in advance. Lastly, the OMB can use the Office as expert consultants in a field where a mix of technical, legal and economic skills are a requisite for sound counsel.

In addition, the Forum is in an excellent position to seek input from private sector interests, public interest groups, and disinterested parties. A private pleading by an industry association or a firm may be inappropriate or unheard if it is directed to an Executive agency. But it would find an open door in the Forum. The reason is clear: the Forum can act as a "third" party, accumulating different viewpoints for consideration by all. It need not take a protagonist role, as would an Agency. It thus need not be defensive or strategic.

The same principle applies with public interest groups. Organizations such as Common Cause, Public Citizen or Citizen's Communication Center can find quick access to the Forum, in a way which might be more costly in a strict adversary (e.g., a court) or quasi-judicial (e.g., a regulatory commission) setting. This access is particularly relevant in a field where public awareness of the issues is low, where organized concern is sparse, but where the impacts will eventually be felt by all.

Lastly, the Forum can invite reasoned comment from disinterested parties who are not lobbying for a particular "client." Organizations such as research departments of Universities or the Aspen Institute can offer valuable scholarly contributions and establish a channel of communication which might otherwise be dispersed or lost completely.

This recommendation can be refined into a more specific call for action. However, that duty is beyond our immediate task, and is left undone.

2. Monitoring the Information Activity

Recommendation 2:

> *The Bureau of Economic Analysis (BEA) should be requested to review the usefulness of constructing permanent information sector accounts.*

Our project has received inquiries from several quarters regarding the possible institutionalization of the information sector in the National Income and Product Accounts. The decision is the prerogative of the Bureau of Economic Analysis (BEA), a sister agency in the Department of Commerce. OT can, however, recommend action on this question

The argument against institutionalization is that the concept of an information activity has not yet been reviewed by the scientific and policy communities. Without "external validation" as to the usefulness of information sector accounts, we feel that a recommendation to institutionalize is not justified.

The argument in favor of institutionalizing the accounts are: (i) to develop a meaningful time series for academic research purposes, and (ii) to establish a foundation for further discussion on information policy issues.

On the academic agenda, it is clear that meaningful econometric analysis is stalled without systematic time series data, gathered in a consistent, accurate and timely manner. The cross-section (1967) developed in this study does not meet the academic objective. Also, no research effort can hope to achieve the turnaround time of the BEA in producing annual estimates. If current reports are in demand, then the BEA is a natural agency to approach.

On the policy agenda, we have discovered that the existence of a single set of (1967) accounts has served as a foundation for political conjectures and assertions. The very existence of an official set of accounts serves to focus policy attention on previously ignored issues. For example, after the Department of Commerce started producing reports on capacity utilization, policy attention regarding that important statistic was heightened.

If the information sector accounts are deemed useful, the BEA will require some additional resources. By our experience, one professional staff member (on a budget of $50,000 annually) is sufficient to pfoduce a set of primary and secondary sector accounts.

A closing note in support of BEA collaboration is in order. The Organization for Economic Cooperation and Development (OECD) has recently established an Information, Computers and Communications Policy group. In structuring its research agenda, the group implemented a program on "macro-economic analysis of information activities."[13] The agenda calls for research to:

"(i) analyse and quantify information activities and services in terms of national accounts and employment;
(ii) assess the growth of electronics, telecommunications and related industries;
(iii) assess the innovation potential of these technologies for an economy; and
(iv) investigate the socio-economic consequences of information technologies upon:
  -- economic growth
  -- employment
  -- existing industry structures
  -- the present international division of labour and thus on the pattern of trade."

Twelve countries have expressed "high priority" interest in the program, and three have begun to build national accounts of their own information sectors.[14] A natural progression of the research has led to inquiries of collaboration with the various national ministries of economic statistics and national accounting.

U.S. participation and leadership in this venture would be significantly aided were the BEA to join the effort. In fact, several European nations have already inquired whether formal research ties between the relevant economic ministries could be established. The purpose of collaboration would be to ensure that construction of national information accounts proceeds with some degree of international agreement and consistency. The BEA stands as the single relevant U.S. authority, and its collaboration is therefore invited.

FOOTNOTES

[1] This chapter addresses, in the skeptic's vernacular, the question "so what?"

[2] See for example Manley R. Irwin and Steven C. Johnson, "The Information Economy and Public Policy," *Science*, Vol. 195, No. 4283, March 18, 1977.

[3] This perspective is developed in more detail in Porat, *The Information Economy*, *op*. *cit*., "Epilogue."

[4] The Office of Technology Assessment recently launched a new Program on Telecommunications, Computers, and Information Policies, at the urging of Senators Kennedy, Hollings and Magnuson (March 1977).

[5] See Porat, *The Information Economy*, "Epilogue," *op*. *cit*.

[6] Samuel D. Warren and Louis D. Brandeis, "The Right to Privacy," *Harvard Law Review*, Vol. IV, No. 5, Dec. 15, 1890.

[7] See, for example:

Eugene Rostow, et al., "Final Report, President's Task Force on Communications Policy," U.S. Government Printing Office (GPO), Washington, 1968.

Paul Baran, "Potential Market Demand for Two-Way Information Service to the Home: 1970-1990," National Technical Information Service (NTIS), Springfield, Virginia, 1971.

Committee on Telecommunications, National Academy of Engineering, "Communications Technology for Urban Improvement," NTIS, Springfield, Virginia, 1971.

Martin Greenberger, ed., *Computers, Communications and the Public Interest*, Johns Hopkins Press, Baltimore, 1971.

Harold Sackman and Norman Nie, eds., *The Information Utility and Social Choice*, AFIPS Press, Montvale, New Jersey, 1972.

Denver Research Institute, "Technological Innovations in Video and their Potential Market, Institutional and Consumer Impact," NTIS, Springfield, 1973.

U.S. Department of Health, Education and Welfare, "Records, Computers, and the Rights of Citizens," GPO, Washington, D.C., 1973.

Arthur D. Little, Inc., "The Consequences of Electronic Funds Transfer," GPO, Washington, D.C., 1975.

National Telecommunications Planning Branch, "Telecom 2000," Australian Telecommunications Commission, Melbourne, 1975.

Singer Corporation, "Computer/Communications Networks on a Communitywide Basis," NTIS, Springfield, Virginia, 1975.

Staff of the Domestic Council Committee on the Right of Privacy, "National Information Policy," GPO, Washington, D.C., (Stock No. 052-003-00296-5), 1976.

Office of Technology Assessment (OTA), "The Feasibility and Value of Broadband Communications in Rural Areas," OTA, Washington, D.C., 1976.

Aspen Institute Program on Communications and Society, "Task Force on Communications Policy-Making," (forthcoming).

Donald R. Ewing and Roger K. Salaman, "The Postal Crisis: The Postal Function as a Communications Service," GPO, Washington, D.C., 1977.

Arthur D. Little, Inc, "Telecommunications and Society, 1976-1991," Report to OTP, (TP 6AC-017), June 26, 1976.

[8] The latest planning initiatives started with the Humphrey-Javits Bill (S. 1795) called the "Balanced Growth and Economic Planning Act of 1975." It was preempted by the Humphrey-Hawkins Act, and is still in Committee. The Act would have created a Division of Economic Information under an Economic Planning Board in the Executive Office of the President. The Planning Board, according to the Humphrey-Javits version, would have the "responsibility for anticipating the Nation's economic needs, measuring available economic resources, assuring an adequate supply of industrial raw materials and energy, outlining economic goals, and in the light of long-range economic trends and opportunities, for developing a proposed balanced economic growth plan, and recommending policies to achieve the objectives of the plan."

Wassily Leontief, Leonard Woodcock, Leon Keyserling and several Senators (including Bayh, Clark, Eagleton, Jackson, McGee, McGovern and Nelson) and some industrialists support the idea. Strong opposition comes generally from Walter Heller and Herbert Stein and the economics profession in general. Stein states that the notion of planning "reflects a romantic, over-rationalized view of how things get done in our economic and political system." (See H. Stein, "Economic Planning and the Improvement of Economic Policy," American Enterprise Institute for Public Policy Research, Washington, D.C., September 1975). The Carter Administration has not declared its position on economic planning. From the composition of the Council of Economic Advisers (especially the Chairmanship), we can infer a go-slow approach, with some planning mechanisms expected but not implemented.

The organization of economic data, as embodied in the proposed "Division of Economic Information," is a key feature of information policy. The nation's commitment to planning, as it develops, will eventually focus on the practical aspects of organizing and using economic information.

[9] See the discussion on the Federal paperwork burden in Chapter 8. The $40 billion estimate was produced by the National Commission on Federal Paperwork.

[10] It is noteworthy that the research on the information economy was conducted in 1976 using the most recent complete input-output matrix available. That was for 1967.

In 1978, the Bureau of Economic Analysis will produce the 1972 input-output matrix. In 1980, the Bureau of Labor Statistics will provide an industry-by-occupation matrix for 1975.

[11] The three major reorganization studies on telecommunications and information policy are:

Domestic Council, *National Information Policy*, GPO, Washington, D.C. (#052-003-00296-5).

Arthur D. Little, Inc., "Telecommunications & Society, 1976-1991," Report to OTP, 1976.

McKinsey & Company, Inc., "Assessing Organizational Alternatives for the Office of Telecommunications Policy, (unpublished report to OTP), 1976.

[12] The "vertically" oriented agencies include OTP, OT/Commerce, NASA (Communications Group), NBS (Institute for Computer Science and Technology), GSA (Computer and Data Processing Division), FCC (Chief Engineer and Spectrum Management), and elements of DoD.

[13] Reported in the Directorate for Science, Technology and Industry Document DSTI/ICCP/77.5.

[14] The twelve countries are: Australia, Canada, Denmark, Finland, France, Germany, Ireland, Japan, Sweden, Turkey, the United Kingdom and the U.S. France, Germany, and the U.K. have begun building information sector accounts along the lines of the U.S. effort.

FORM OT-29
(3-73)

U.S. DEPARTMENT OF COMMERCE
OFFICE OF TELECOMMUNICATIONS

BIBLIOGRAPHIC DATA SHEET

1. PUBLICATION OR REPORT NO. 77-12(1)

2. Gov't Accession No.

3. Recipient's Accession No.

4. TITLE AND SUBTITLE
THE INFORMATION ECONOMY: Definition and Measurement

5. Publication Date
May, 1977

6. Performing Organization Code

7. AUTHOR(S)
Dr. Marc Uri Porat

8. PERFORMING ORGANIZATION NAME AND ADDRESS
Office of Telecommunications
U.S. Department of Commerce
1325 G Street, N.W.
Washington, D.C. 20005

9. Project/Task/Work Unit No.

10. Contract/Grant No.
APR-7609015

11. Sponsoring Organization Name and Address
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

12. Type of Report and Period Covered

13.

14. SUPPLEMENTARY NOTES

15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report series defines and measures the "information activity" within the national economy. "Information activity" is defined to include those specific industries and occupations whose primary function is to produce, process or transmit economically valuable information. Changes in the national labor force are analyzed over a 120-year span. Information activities have grown dramatically over the last several decades, until they employed 46% of the labor force in 1970. National Income and Product accounts are analyzed to determine the contribution of the information activities to wages and capital expenditures. Information workers earned 53% of total wages in 1970; 46% of value added was derived from information activities in 1957. Input-Output tables have been constructed which show the detailed structure of the information economy.

Volumes 1 and 2 summarize the findings. Volumes 3, 4, and 5 set forth the Input-Output tables. Volumes 6 through 8 detail the workforce and National Income accounts. Volume 9 describes the database available on computer readable magnetic tape.

16. Key Words *(Alphabetical order, separated by semicolons)*

Economic Research;
Employment Statistics;
Employment Trends;
Information Economy;
Input-Output Economics;
National Income Accounts

17. AVAILABILITY STATEMENT
☒ UNLIMITED.
☐ FOR OFFICIAL DISTRIBUTION.

18. Security Class *(This report)*
Unclassified

19. Security Class *(This page)*
Unclassified

20. Number of pages
265 pp.

21. Price:

USCOMM-DC 29716-P73

☆U.S. GOVERNMENT PRINTING OFFICE: 1977-240-848/195

3 9